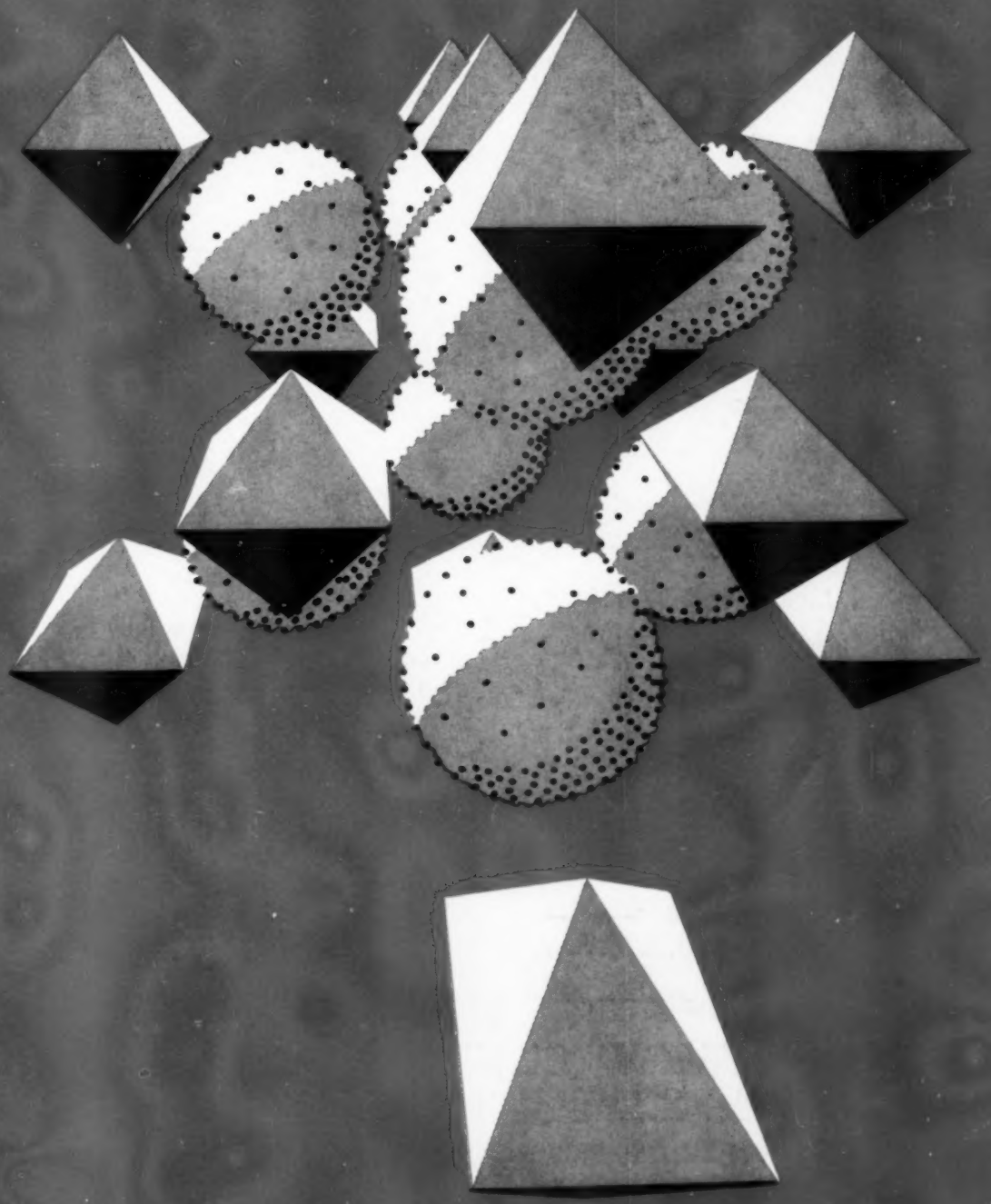
Vol. XXIV, No. 6
OCTOBER, 1957

THE SCIENCE TEACHER



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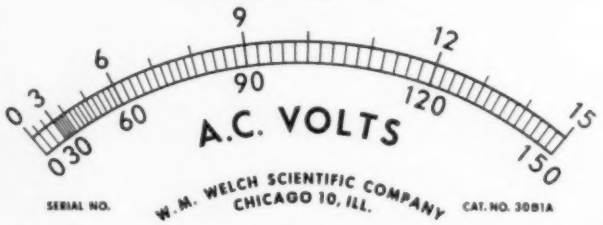

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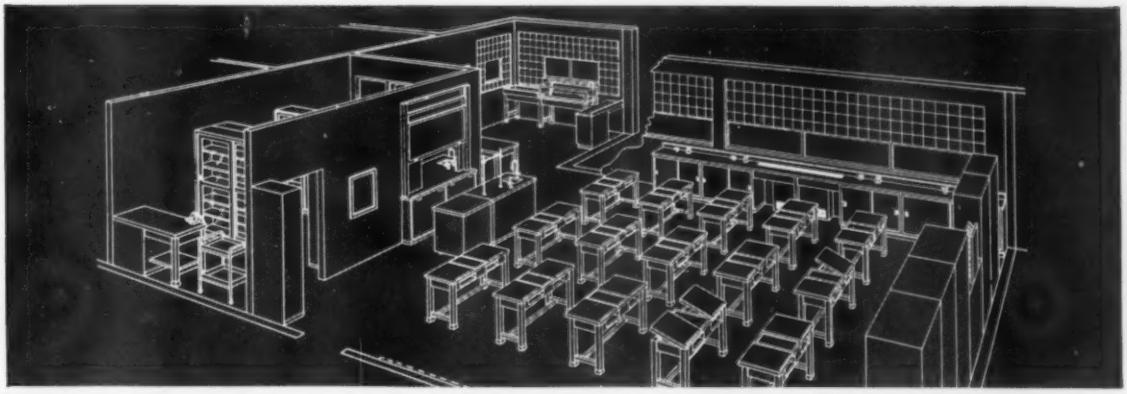

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The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

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Editor's Column

Relatively few readers of this column this month will have known Laurence K. Replogle. When he died of cancer at age 58 last June, the Columbus, Ohio, *Dispatch* editorialized: "A Dedicated School Man . . . versatile, practical, and keenly observant; responsible for numerous improvements and innovations in the local school system during 20 years as assistant superintendent. Memories of his attractive, genial, outreaching personality will be cherished by thousands of professional associates, teachers, students, and friends who knew its warmth over many years."

I remember "Rep" best as an enthusiastic, inspiring young teacher of high school chemistry. I was fortunate enough to be in one of his classes, and this led to his becoming one of two or three landmark influences in my own career development.

As a high school junior, I went into his class with "special permission" because chemistry was not even an elective in the commercial curriculum in which I was then enrolled. I had no ambitions or prospects of going to college. Fifteen of us in Rep's classes that year became so stimulated and enthused that we persuaded him—with the approval of a sympathetic principal—to give us a second year of chemistry as seniors. This "course" was an extra on his part and ours. We scheduled all our study hall or other free periods in the chemistry laboratory, plus sessions after school and frequently on Saturday mornings.

I came out of this course with three firm decisions: first, the determination to go to college; second, the decision to major in chemistry; third, the goal of becoming a high school chemistry teacher—as good a one as Replogle was if possible. If my carry-through on these points can be called a career in science, then 13 of the 15 boys in Rep's second-year chemistry course ended up with careers in science.

Why, you might ask, this long, personalized recital? First, it's because I want to express publicly my sincere respect and appreciation for all that Laurence K. Replogle did for me. Second, I believe we can see in his work a cause and a symbol. What I have recounted happened 30 years ago, long before there was a "shortage of scientists and engineers" and a national crisis that has stimulated the President himself to appoint a committee to work on the problem. It may well be that the great expansion of the scientific effort, producing needs for manpower in excess of present supply, is the result of the good work done through the years by the many L. K. Replogles in our profession. And it is because we have many such teachers at work in our classrooms today that my view of the future is not nearly so dim as that which is taken by some of our critics.

Robert H. Carleton

THE SCIENCE TEACHER

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Next Month . . .

in *The Science Teacher*

A Special Report on the Physical Science Study at the Massachusetts Institute of Technology with By-lined Articles by Leaders in the Study.

Shown at Bell Laboratories, Murray Hill, N. J., are, left to right, F. J. Herr, S. T. Brewer, L. R. Snoke, E. E. Zajac and F. W. Kinsman.

They're wiring the seas for sound

These five Bell Labs scientists and engineers may never "go down to the sea in ships." Yet, they're part of one of the most exciting sea adventures of modern times. Along with many other specialists, they are developing the deep-sea telephone cable systems of the future.

Here's how they join many phases of communications science and engineering — to bring people who are oceans apart within speaking distance.

F. J. Herr, M.S., Stevens Institute, is concerned with systems design and analysis. He studies the feasibility of new approaches and carries out analysis programs to select optimum parameters for a proposed system design.

S. T. Brewer, M.S. in E.E., Purdue, communications and electronics engineer, explores new designs for sea-bottom amplifiers needed to step up power of hundreds of simultaneous telephone conversations.

L. R. Snoke, B.S. in Forestry, Penn State, is the team biologist. He investigates the resistance of materials to chemical and microbiological attack in sea water. Materials are evaluated both in the laboratory and in the ocean.

E. E. Zajac, Ph.D. in Engineering Mechanics, Stanford, is a mathematician. He studies the kinematics of cable laying and recovery. Cable's dynamic characteristics, ship's motion, the mountains and valleys in the ocean bottom — all must be taken into account.

F. W. Kinsman, Ph.D. in Engineering, Cornell, solves the shipboard problems of storage, handling and "overboarding" of cable. New machinery for laying cable is being developed.

Deep-sea cables once were limited to transmitting telegraph signals. Bell Labs research gave the long underseas cable a voice. New research and development at the Labs will make this voice even more useful.

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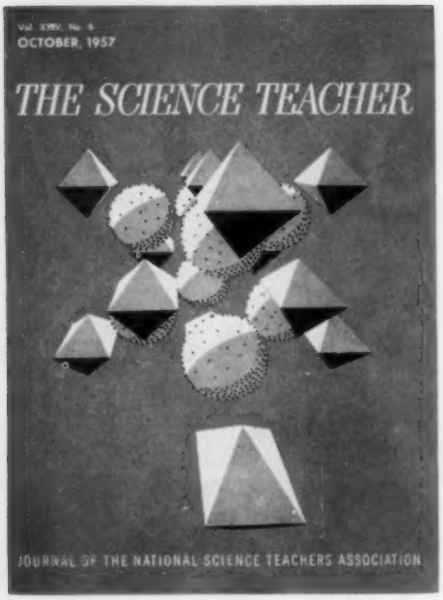

is an artist's interpretation of the structure of crystalline nickel hexammine chloride $Ni(NH_3)_6Cl_2$, as presented in Linus Pauling's textbook, *College Chemistry*. As one of the important organic compounds, it is featured on the cover because of the significance of the world of chemistry today to both the science teacher and his student, the potential scientist.

The future scientist is in the national eye this month. October has been designated National Science Youth Month by the U. S. President's Committee on Scientists and Engineers. An illustrated summary of this project's program and objectives appears on pages 266 and 267 of this issue of *TST*.

The cover's chemistry motif also reflects a personal editorial viewpoint as reported in the Editor's Column on page 252. From a different editorial viewpoint, the color of this month's cover represents a kind of chemical deviation from the previous *TST* custom of using one basic color during the calendar year. But, in a world of change that is as changing as the practices of chemistry, is this not appropriate?

Another feature of the current issue is Roger Revelle's article on "Weather, Sea, and Ice Studies in the IGY," beginning on page 260. This is one of scheduled bimonthly reports on the work and accomplishments of the IGY.

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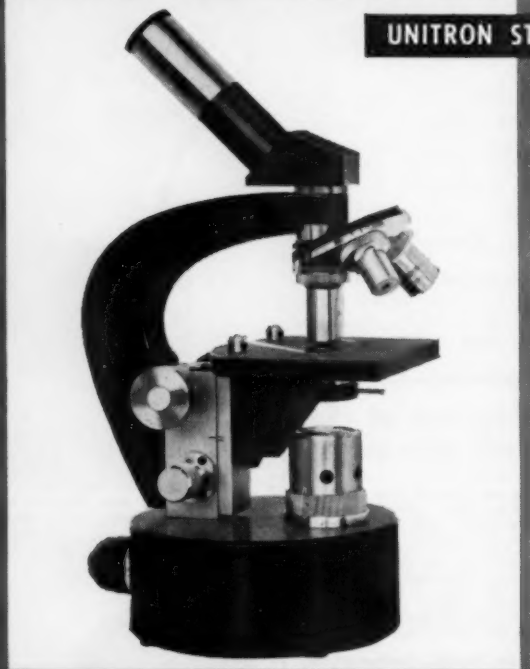

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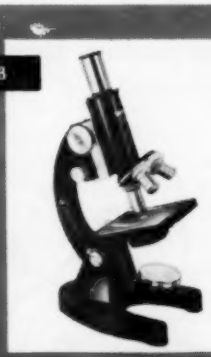

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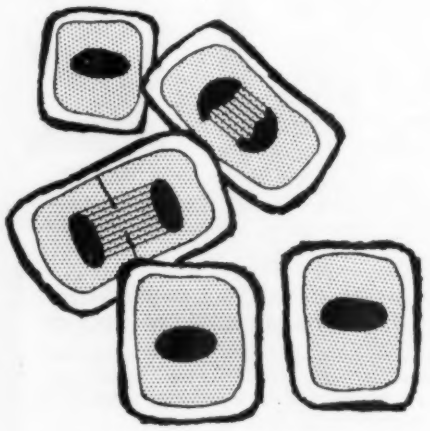

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Reader's Column

I have been a student member of NSTA for a year now and am very pleased with the services of the Association. I am especially pleased with the journal, *The Science Teacher*. It would be very helpful to all prospective science teachers to join the Association while still in college.

RONALD O. KAPP
Botany Department
University of Michigan, Ann Arbor

Please send copies of the April and May 1957 issues of *The Science Teacher*. Remittance is enclosed. There must have been some remarkably good material in these for they have disappeared from the shelves.

NELLIE R. SWANSON
Librarian, State Teachers College
Minot, North Dakota

We recently placed a library subscription to your publications and have been very favorably impressed with the amount and quality of supplementary materials which you supply in your packets of teaching aids.

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Librarian
University of Minnesota, Duluth

A letter in the Reader's Column in one of the spring issues of *The Science Teacher* reminded me of my sincere gratitude to the Future Scientists of America Foundation and the Crown Zellerbach Foundation. I was a Fellow at the 1956 summer conference, co-sponsored by the two, which was reported in *TST* last fall under the title of "Science Projects as Stepping Stones to Careers in Science." As a result of my Fellowship and for other reasons, I applied for the academic-year institute at Oregon State College. This institute, as you know, is possible because of a grant from the National Science Foundation. I was very happy when I was selected to participate.

I would also like to report that I look forward to receiving the journal. I usually find much valuable information in *TST* and its contents stimulate my enthusiasm for science teaching to new heights.

CHARLES H. SCHROEDER
Kelso, Washington, Junior High School

You asked for suggestions for *TST* (May Editor's Column). For one, please try to arrange the Classroom Ideas so they can be cut out and filed separately. When the new copy of the magazine arrives, it is a problem to decide who is to get it first. The individual Classroom Ideas are usually too long to be copied. Also, with part of an article conflicting with another article on the back of the page, filing is impossible. And what does one do if a student loses the whole copy?

TST has helped me in so many ways; it's difficult to say what has meant the most to me. This much is sure: there is something added to the teacher-pupil relationship when his teacher's, his school's, and his own name appear in a national magazine of *TST's* caliber.

FLORA KAHME
Herricks Junior High School
New Hyde Park, New York

Your publication, *The Science Teacher*, impressed me very much. I am enclosing my check to cover my membership fees for the coming year. I would appreciate some membership promotion material to show the other members of our staff.

MARTIN H. SILVERMAN
Science Chairman, Junior High School 62
Brooklyn 29, New York

I am sorry I am slow in renewing my membership, but I do want to express my thanks for the good job you do, and the helpful articles in *The Science Teacher*. Keep up your good work.

ROSS W. WESTOVER
Tooele, Utah

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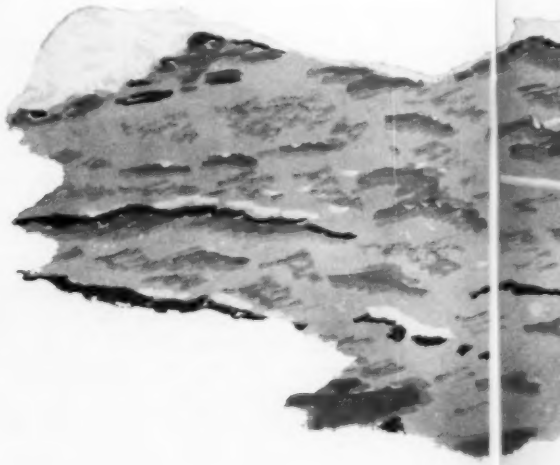
WEATHER, SEA, a in the IGY



By ROGER REVELLE

Director, Scripps Institution of Oceanography, La Jolla, California

CLIMATE has profoundly affected man's history upon earth and influenced the course of entire civilizations. Its local aspect, the weather, has smiled or frowned upon man's comfort and safety, his travel and communications, down through the ages. Yet for almost 2000 years, man's curiosity was satisfied with Aristotle's primitive notions about the weather. Not until the time of Benjamin Franklin did man begin to think of weather in terms of movement and patterns.

Today, the weather is understood as the product of complex interrelationships in the seas of air, water, and ice around us. Their action and interaction constitute a kind of heat and water budget of the earth—a great system which is in fundamental equilibrium but which depends upon the enormous energy of the sun to keep it from running down.

To study these interrelationships during the International Geophysical Year, hundreds of scientists have coordinated their efforts and even now are gathering data in both near and remote places on the transfer of heat and moisture in the atmosphere, the seas, and the glaciers.

It is hoped that the IGY will give us new data to help in finding answers to questions such as:

What causes hurricanes?

How does the sun's energy drive the great heat engine of the earth?

How long does it take for the oceans to complete their circulation from the polar regions to the equator and back again?

Is the climate of the earth changing?

Is carbon dioxide from the burning of fuels building up enough atmospheric heat so that, in time, the earth's weather may change appreciably?

Weather

One of the major programs of the IGY is in meteorology, the study of the earth's lower atmosphere. To the atmosphere we owe oxygen, water, and insulation against deadly solar shortwave radiation. But none of its properties is more important than its motion. Winds distribute heat from the tropics to other parts of the world, carry moisture from the oceans to the continents, and replace polluted air of the cities with clean air. If our entire atmosphere were to fall into a dead calm, the tropics would become intolerably hot and the rest of the planet, unbearably cold; the parched continents would become dust; cities would suffocate. Fortunately, the atmosphere is circulating continuously over the globe.

Enormous energy is required to drive this circulation—energy equal to more electric power than all U. S. power plants could generate in 100 years. It is necessary that this energy be replenished every nine to 12 days; otherwise friction between the earth's surface and the atmosphere would slow all

winds to a halt. The source of virtually all of this new energy is the sun. Tropical and subtropical areas absorb more solar radiation than they lose while the rest of the world radiates more than it absorbs. However, the earth is in approximate thermal equilibrium—neither heating nor cooling much over-all on a yearly basis. This equilibrium is assumed to be maintained by movement of air from equatorial to polar regions. This fundamental movement, combined with the earth's rotation, results in a global circulation system; the cyclones and local wind patterns of our weather charts are mere eddies in this system.

One of the aims of the IGY is to determine in greater detail the real pattern of atmospheric circulation, about which much remains unknown. The scope of this problem is illustrated by the fact that the ocean of air in which we live is so vast that if it were divided up for observation among all of the people on earth, each person would be required to watch approximately 2,000,000 tons of air.

In order to carry out the U. S. program, under the direction of the IGY Committee of the National Academy of Sciences, many new meteorological stations have been established, primarily in the Arctic and Antarctic regions. In addition, the U. S. National Committee has cooperated with foreign national committees in setting up meteorological stations along the west coast of South America.

As an illustration of the breadth of this program, weather information is being collected in over-snow traverses, on aircraft flights, at two drift-ice stations in the Arctic, at the South Pole, and at many fixed stations.

Existing facilities, mostly stations in the continental United States which were operating prior to the IGY, have been improved with the introduction of new equipment designed to increase the accuracy and scope of observations.

A considerable amount of weather data has already been gathered about heretofore unknown Antarctic areas. A temperature of —102.1° F., the lowest recorded anywhere to date, was measured at the IGY Amundsen-Scott Station at the South Pole last month. Newly-developed weather balloons have taken soundings at heights of slightly more than 90,000 feet at the South Pole, and it is expected that similar balloons will soon reach 100,000 feet or more. These balloons are equipped to make continuous measurements of temperature, pressure, relative humidity, and air density; the data are transmitted back to the ground station by radio. Direction, velocity, and vertical distribution of winds are obtained by radar tracking of the balloons.

At present, IGY Antarctic Weather Central, staffed by meteorologists from three participating countries, is broadcasting the results of day-to-day weather analyses. This is the first time in history

and ICE STUDIES

that such an activity has been attempted in Antarctica. The analyses, reaching the entire Southern Hemisphere twice daily, are used for forecasting. Raw data are received by Weather Central, located at Little America Station, from other U. S. Antarctic stations, from Antarctic stations operated by other countries, and from Australia, New Zealand, South Africa, and South America.

Synoptic weather data accumulated and analyzed at Antarctic Weather Central will ultimately help clarify the heretofore obscure influence of the Antarctic continent on the large-scale hemispheric and global circulation patterns. New Zealand meteorologists already report that IGY Antarctic weather data have brought about significant improvement in local weather forecasting.

The Oceans

IGY scientists are studying the deeper waters in the oceans and making a continuous record of changes in sea level at island and coastal tide gauge stations throughout the world. Study of the physical and chemical properties of the seas is also included in IGY oceanographic work.

Because of the difficulty and expense of making subsurface measurements, virtually nothing is known about the deeper ocean currents. It is not known, for example, whether it takes 100 years or 10,000 years for the deep water to move from the Antarctic to the equator and back again. The practical significance of these studies is great. Knowledge of the deep ocean currents will be of great value in long-range weather forecasting, particularly because of water exchanges between the Antarctic and the low latitudes. The fertility of the oceans—the amount of fish and other food obtainable—is limited by the rate at which the ocean waters overturn, thereby refertilizing themselves. In order to estimate, and, perhaps, some day affect, the potential food supply from the seas, we must understand the deep currents. Further, the development of peaceful uses of atomic energy will undoubtedly result in vast quantities of radioactive waste materials, which must be safely disposed of. Whether they may be dumped safely into the deep sea depends in part upon the rate at which the deep waters mix with those near the surface.

Considerable effort is being expended to obtain information about the shape of the deep-sea floor and the composition and stratification of bottom sediments. We cannot really understand such things as the distribution of mineral deposits, especially those resources which feed our industrial machines, until we know more about the history of the earth—and we cannot get much further with this history until we learn more about the three-fourths of the earth that is covered by water.

In all, more than 70 ships, operated by approximately 35 participating countries, will have been engaged in deep-water scientific investigations when the IGY ends in December 1958. The Woods Hole Oceanographic Institution research vessel *Atlantis* and the British *Discovery II* did some of the earliest work last March; they conducted joint operations along the outer edge of the Blake Plateau, in the western Atlantic at about the latitude of Charleston, South Carolina. The *Atlantis* measured deep temperature and salinity, while the *Discovery* tracked recently-developed, neutrally-buoyant floats at selected levels to determine the velocity and direction of deep currents. The floats contained sound sources, and tracking was done with hydrophones attached to the ship. The floats revealed the presence of a rapid, southwest-flowing countercurrent below depths of about 6500 feet. The surface current in that region is the well-known Gulf Stream, flowing northeast.

The IGY program for observation of sea level changes is being conducted at about 100 newly-established stations, in addition to the many tide-gauge stations already in existence. We know that sea level varies with the seasons. In summer and autumn it is about a foot higher on the average than in winter and spring. The island observatory program gives us an inexpensive means, using observation points on land, of measuring the changing motions of the oceans.

Glaciers and Icecaps

About three per cent of the earth's surface is now covered by icecaps, principally in Greenland and Antarctica, and a total of about ten per cent is covered by ice and snow in all forms. These vast areas of ice, in addition to their strong influence on weather over wide parts of the earth, hold captive great volumes of water. A melting of two feet per year over the surfaces of the icecaps alone would raise sea levels about ten feet in 100 years. This seemingly small change would seriously affect many coastal regions.

A thorough investigation by IGY scientists of the physical and chemical aspects of the world's ice sheets, fields, packs, and glaciers is under way. These ice bodies are remarkable indicators of climatic change, although it is not yet clear how they should be read. During warm periods, or when precipitation is reduced, the glaciers appear to decrease in volume and extent; when the atmosphere cools, or snowfall increases, they grow thicker and advance rapidly. But in certain circumstances, these

relationships may be reversed. Answers to these and similar problems may be found in the layers of ice which have been laid down year after year to form an unrivaled record of past events in earth history. For example, in snow stratigraphy studies made prior to the IGY on the ice sheet about 200 miles east of Thule, Greenland, ash from the 1912 eruption of the Alaskan volcano Katmai was uncovered 105 feet below the 1954 surface.

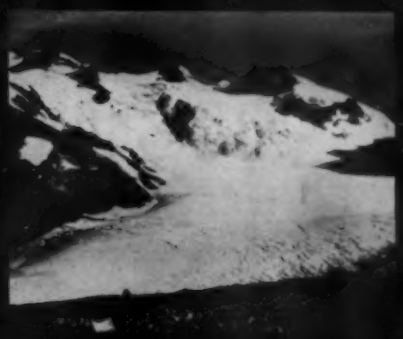
Among the most significant glacial studies from the standpoint of the earth's heat and water budget, are those concerning the thickness of the ice and the rates of accumulation and wastage. Ice composition and structure, both gross and microscopic, are also being studied.

An historic 647-mile glaciology-seismology traverse in the Antarctic from Little America Station to Byrd Station, far out on the icecap, was completed early this year. The resulting seismic profile indicates an increase in ice thickness from about 2000 feet at the beginning of the traverse, 200 miles from Little America, to about 9850 feet at Byrd Station. The elevation of Byrd Station is 4950 feet above sea level. Hence, the surface of the earth's crust on which the ice rests in this area is almost 5000 feet below sea level. This unexpected result reveals an interesting and as yet unexplained geological aspect of the Antarctic.

In addition, much aerial mapping of glaciers, snowfields, and floating pack ice in Alaska, the continental United States, and the Arctic Ocean, is being organized for the IGY as part of an aerial weather reconnaissance program.

Now under study by US-IGY glaciological field parties are the McCall and Lemon Glaciers, in Alaska, and the Blue Glacier, in the Olympic Mountains of Washington State. The work on the McCall Glacier represents the first direct scientific study of an Arctic alpine glacier. The IGY team there is engaged in snow stratigraphy, micro-meteorological surface movement, and photogrammetric observations. A recent report from the project leader states that it has become clear that all significant snow accumulation on these glaciers occurs during the summer months. These detailed studies of the dynamics of glacier movement, their cycle of accumulation and wasting, and related problems in glacier morphology and chemistry, will also yield knowledge on recent climatic changes in areas where meteorological records are poor or nonexistent.

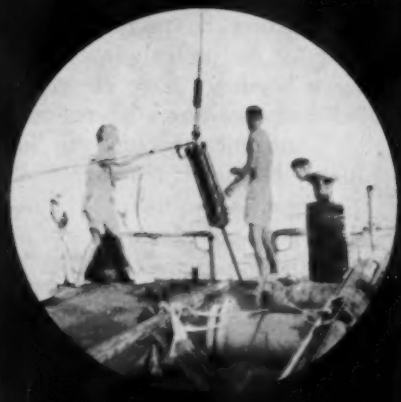
Through the great concentrated effort of the IGY, the equivalent of a dozen and more years of observations is being achieved in 18 months. Man's knowledge of his environment, and his ability to cope with it, grows at an ever-increasing pace!



Blue Glacier, in Olympic National Park, site of one of the IGY alpine glacier study stations. (A. E. Post)

Glaciologist taking snow stratigraphy cores in the Arctic. (USNC-IGY)

Release of rawinsonde weather balloon on Fletcher's Ice Island in the Arctic Ocean. (Capt. R. S. Smith)



Oceanographers lowering temperature probe to measure temperature gradient in deep-sea bottom sediments. (Scripps Institute of Oceanography)

High-altitude rawinsonde balloon being released outside rawin tower at Byrd Station on the Antarctic icecap. (USNC-IGY)

HISTORICAL MATERIALS
and High School Science Teaching

By LEO E. KLOPFER

Willimantic State Teachers College, Connecticut

and FLETCHER G. WATSON

Graduate School of Education, Harvard University, Cambridge, Massachusetts

This article is based on a symposium presented at the 4th National Convention of the National Science Teachers Association, on March 15, 1956, in Washington, D. C.

MANY SCIENCE TEACHERS today are rightly concerned about attaining what are frequently referred to as the "intangible objectives" of science instruction. That our students should attain thoughtful appreciation of science, scientific attitudes, and interests in science are vital objectives for science instruction, which can hardly be argued in the present day. Yet, relatively little thought has been given to how these important objectives may readily be reached by classroom teachers and there are few instructional materials designed specifically for this purpose.

Certainly, it is inadequate to say hopefully that scientific appreciations, attitudes, and interests will arise spontaneously (in some undescribed way) when students take a well-planned course in physics, chemistry, biology, or general science. Unless a certain outcome is specifically designed into our teaching, it is unlikely to have been achieved when our students have completed the course. Thus, if we want our students to attain these "intangible" outcomes through our instruction, we must make specific plans to achieve them. The theme of this paper is that the use of historical materials can serve as an effective means of achieving these desirable and important outcomes in high school science teaching.

This notion of using materials from the history of science to teach high school students what the scientific enterprise is all about is not simply a wild, untested idea. We take our cue from the successful use of historical materials in general education science courses in colleges.

Inevitably any course involves a selection of teaching materials and topics, for no one can hope to consider all the available information, even within a small section of one science. Faced with this fact and deeply concerned about offering adequate instruction in science to the great majority of students who do not become scientists, many colleges have designed special science courses for this large audience. To show these students how scientists actually go about the complex task of finding new facts, organizing them, and testing hypotheses through experimental confirmation of predictions, several universities (Chicago, Colgate, Harvard, and others) have explored the use of "cases." A "case" involves the critical study of the development of a major scientific concept. A case is then one form of a unit. Because a case is concerned with the *development* of new concepts, it not only involves the final results of the scientific inquiry, but stresses the scientists who were involved, the information available to them, their search for better facts and explanations, and the intellectual and social climate in which they worked. Thus, past scientific accomplishments appear as part of our total intellectual and social history. Emphasis upon the development of concepts allows transfer of the ideas stressed to current and future scientific efforts.

Under the leadership of James B. Conant (see *On Understanding Science*), cases have been developed at Harvard for use in one of the seven general education courses in science. These cases, published as the *Harvard Case Histories on Experimental Science* (Harvard University Press), were chosen on the basis of several criteria. First, they must illustrate several major aspects of creative scientific work. Second, the factual details must be sufficiently simple to be thoroughly mastered by the students so they can recognize the difficulties and subtleties of creating an acceptable explanation. Third, insofar as practical, case

materials should permit the students to see, handle, and repeat the basic experimental evidence. Fourth, cases should be drawn from varied fields of science, both to provide variety in the subject material and to reveal the similarities and differences in creative work on different types of evidence. Fifth, common threads interconnecting the cases must be present to provide some continuity in the instruction. Sixth, a case need not be drawn from the long-past provided the informational details are not too complex for the students to master. Yesterday's science may be used, but its long-term significance is difficult to appraise. The discovery of carbon-14 would be an example of a recent significant result.

Case histories appear to be especially promising for use in the training of teachers. Recently just one case carefully considered opened up to a class of experienced science teachers whole new dimensions in their scientific knowledge and sparked further exciting independent study.

Surely "cases" are not a complete substitute for personal involvement in creative science, but they can aid by focusing attention upon the creative processes and yield insights and approaches profitable in independent research. On his own in the laboratory, the student should recognize how his problems are like those of other inquirers whose decisions may clarify those of the student. The study of history is profitable when it aids us to make wiser decisions about the problems at hand.

The inclusion of material from the history of science in science instruction is not confined to college general education courses, for in secondary schools also the use of historical materials is far from being a rarity. The preliminary results of an informal survey of high school science teachers in various parts of the country indicate that it is current practice for them to use historical materials, often to a large extent. The 35 replies to the survey questionnaire received to date show a wide diversity in the use of historical material; these range from the telling of anecdotes and stories and the reading of historical descriptions in textbooks to modified use of the *Harvard Case Histories*. Some alternates, which are used by a good percentage of teachers (i.e., 65 per cent or more out of 35), include the citing of instances of scientific methods in the past, reading parts of or entire biographies of scientists, suggested readings in the history of science, describing or performing "classical" experiments, and student reports on scientific developments in the past. Some teachers (16 out of 35) have their students carry out projects that reconstruct the scientist's attack on a particular problem, while eight out of 35 reported the study of case histories. The survey also revealed that teachers generally acknowledge the value of historical material in science teaching. The following comments are typical of those returned with the survey questionnaire.

Miss Greta Oppe, Ball High School, Galveston, Texas, wrote:

> I learned to appreciate the history of science through the articles published by the late Edgar Fahs Smith and a visit to his laboratory. I do not agree with those who think the historical approach has no place in high school chemistry.

Lowell Lippincott, a teacher of physics at the Stratford, Connecticut, High School, commented:

> I find the students very much interested in history of science and think we should make more use of it in teaching science subjects.

Martha Kinsey, Emerson Junior High School, Los Angeles, California, suggested using the

> historical approach to show the development of the science in question—i.e., take the class along the way the subject developed. This is good in astronomy, chemistry, and physics especially.

In Baltimore, Maryland, M. Jastrow Levin has used "considerable historical data" in all his teaching. Among eight objectives of his instruction, he cited, for example:

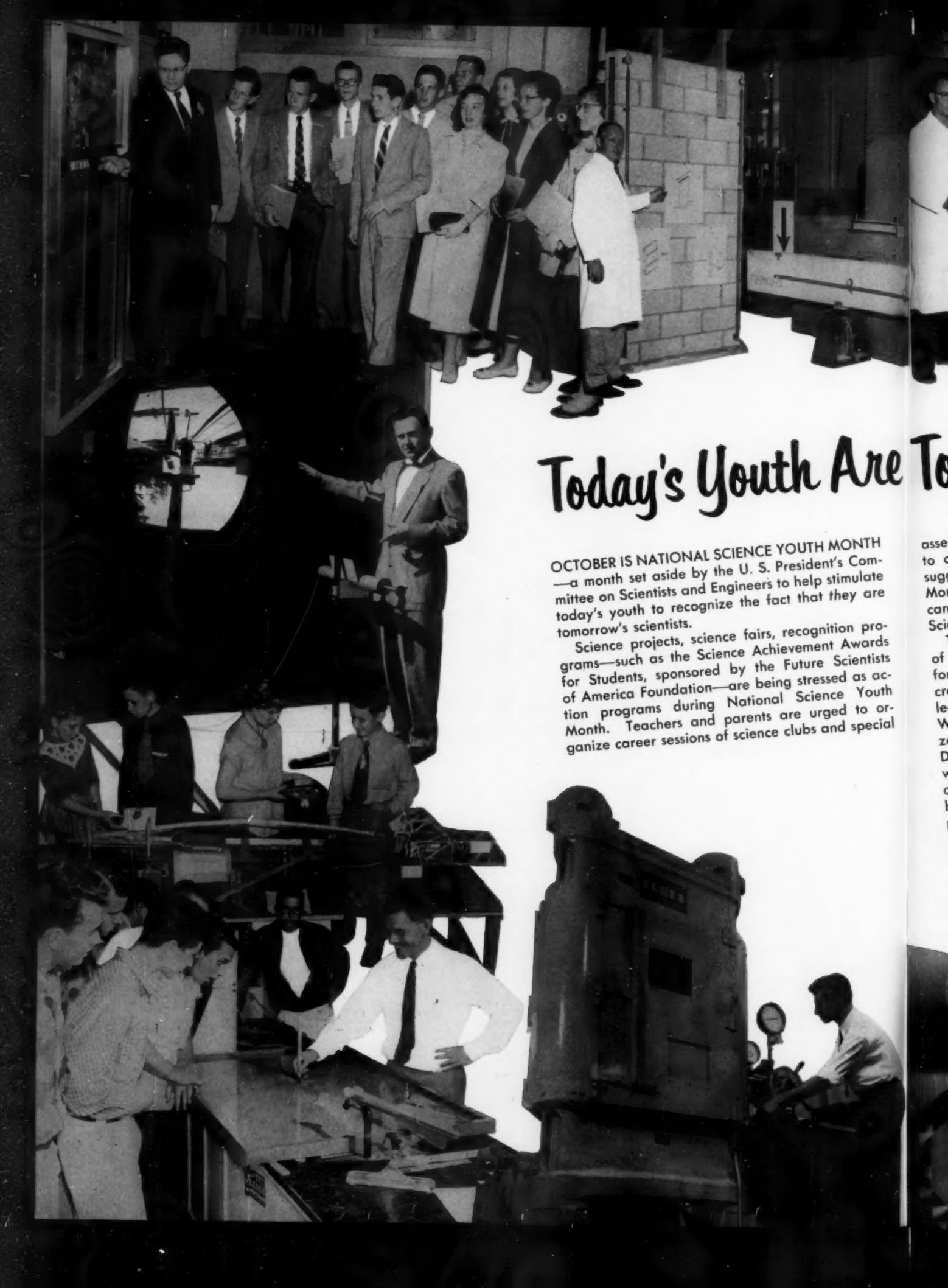
> A most important idea is an understanding of what the scientific method is and how it has been used. In our high school classes we have very little practice in the actual use of the scientific method. We memorize laws and perform experiments. Through historical situations, we may see some aspects of scientific method and we can compare it with what we do.

Mrs. Mae R. Nelson, who uses a good deal of historical material herself in her biology classes at the Robert E. Lee High School, Baytown, Texas, related this incident:

> One of our teachers went back to school one summer and had a course in the history of biology. The next fall she commenced her year's classes in biology with an introduction on this history. I usually commence the year's work with the value of the study of biology and what the parts include. I was surprised how the teacher did arouse interest with the study of the history.

From the last-quoted comment, as well as from

(Continued on page 292)



Today's Youth Are To

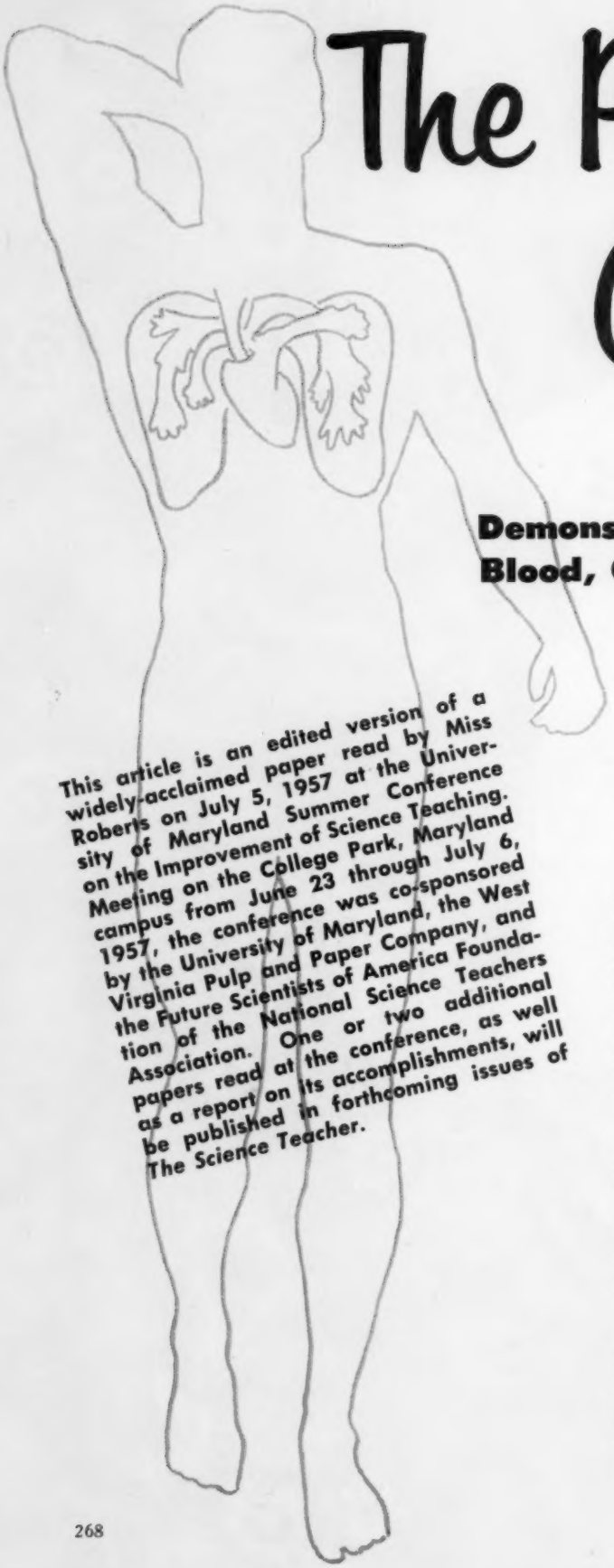
OCTOBER IS NATIONAL SCIENCE YOUTH MONTH —a month set aside by the U. S. President's Committee on Scientists and Engineers to help stimulate today's youth to recognize the fact that they are tomorrow's scientists.

Science projects, science fairs, recognition programs—such as the Science Achievement Awards for Students, sponsored by the Future Scientists of America Foundation—are being stressed as action programs during National Science Youth Month. Teachers and parents are urged to organize career sessions of science clubs and special

re Tomorrow's Scientists

assemblies, to schedule plant and laboratory tours, and to arrange local publicity. A poster presentation of suggested activities during National Science Youth Month, listing the groups cooperating in the program, can be obtained from the President's Committee on Scientists and Engineers, Washington 25, D. C.

The photographs on these pages illustrate activities of both today's and tomorrow's scientists. Lower left, for example, is a picture of students at the Hughes Aircraft Company (Culver City, California) high school lecture-demonstration program. Upper right, Robert H. Wentorf, General Electric scientist who developed borazon, a new hard-as-diamond material. To his left, Dorothy Hollingshead, of Atlanta, Georgia, an award-winning entrant in this year's Science Talent Search, conducted by the Science Clubs of America and sponsored by the Westinghouse Educational Foundation. Other photographs show students at last spring's Guest Week sponsored by the National Bureau of Standards in Washington; younger students working on a study of bridges; Dr. Robert Rice working with students in an American Chemical Society program; and, bottom center, the machine in which borazon is produced (left) and its diamond-like characteristics (right).



The Profits of Curiosity

Demonstrations and Experiments on Blood, Circulation, and Respiration

This article is an edited version of a widely-acclaimed paper read by Miss Roberts on July 5, 1957 at the University of Maryland Summer Conference on the Improvement of Science Teaching. Meeting on the College Park, Maryland campus from June 23 through July 6, 1957, the conference was co-sponsored by the University of Maryland, the West Virginia Pulp and Paper Company, and the Future Scientists of America Foundation of the National Science Teachers Association. One or two additional papers read at the conference, as well as a report on its accomplishments, will be published in forthcoming issues of The Science Teacher.

By MARY POLK ROBERTS

Chairman, Science Department
Towson, Maryland, Senior High School

THE TEACHER OF BIOLOGY is fortunate in that his course can be adapted to the natural interests of high school students without doing violence to the subject matter of his field. Of particular interest to the adolescent is the study of human anatomy and physiology. His curiosity about his own life processes can be utilized to arouse an interest and enthusiasm that will often continue through the more classical subject matter of zoology and botany.

In this report, the topics of blood, circulation, and respiration have been chosen more or less arbitrarily as examples of life processes that can be presented from the human point of view but are applicable to the study of all mammals and some other vertebrates. The experiments suggested have the double advantage of utilizing available materials and of arousing a high level of interest in the participants. The list is not intended to be exhaustive but rather to suggest some procedures to which any knowledgeable teacher can add his own ideas. Although many of the experiments are rather obvious, the detailed instructions may be of help in organizing laboratory work.

BLOOD AND CIRCULATION

The close relationship between the circulatory apparatus and blood is immediately apparent. The fundamental concept in the study of both would appear to be the necessity for continuous transport of materials to and from the cells of multicellular organisms in which direct exchange between the cells and the external environment is impossible. The complex blood and lymph circulating mechanisms of land animals provide a solution to the problems of keeping cells bathed in fluid, supplied with necessary materials, and freed of toxic metabolic wastes.

In most organisms having a closed circulation, a pumping organ and a continuous set of tubes permitting one-directional passage of blood make up the system. The structure of the pump tends toward a greater efficiency and greater muscularity in the so-called higher animals. Blood, although complex and still imperfectly understood, provides an almost inexhaustible source of laboratory procedures. Students can hear the characteristic heart sounds, determine their pulse rates, examine their own venous valves, make indirect measurements of their blood pressure, and carry out a variety of experiments using their own blood.

The following instructions have been used successfully with many different groups of students.

Heart Sounds

Place the bell of a stethoscope between the fourth and fifth ribs (counting from the topmost rib) and slightly to the left of the sternum. With the earpiece of the instrument securely in place and the bell held steady, it is possible to hear two distinct sounds. One is duller and more prolonged than the other. The sounds roughly resemble "lubb-dup." The first sound is due to the contraction of the heart muscle and the shutting of the atrio-ventricular valves, the second to the shutting of the semi-lunar valves. A slight hissing noise between the sounds indicates a defect in one of the valves.

Count the number of times per minute these sounds are heard. Record your findings and compare them to the pulse rate of the same subject.

Arteries, Veins, and Capillaries

In blood vessels leaving the heart, the blood is under considerable pressure; therefore, to withstand this pressure, arteries must be tough and elastic. Veins, however, are usually larger in diameter and thinner-walled. Examine prepared slides showing an artery and a vein side by side.

Blood returning to the heart is not under great pressure and consequently venous return from the extremities would be very poor if some mechanisms preventing backflow were not present. These mechanisms are the venous valves.

Their action can be observed in the veins of the back of the hand or on the underside of the wrist. Slide a finger along the vein in a direction away from the heart. Blood in the vein will be pushed ahead of the moving finger, leaving an empty vein behind. If, however, a valve is present in the area of the vein which has been stroked, the blood will not be pushed beyond it and will remain in the vein. Venous valves permit the flow of blood only toward the heart.

Capillaries

Pith a frog by bending the head of the frog forward and inserting a pithing needle through the space between the top vertebra and the skull. Use a piece of cork or heavy cardboard with a circular hole cut in it. Spread the frog's tongue or the web of one of its feet over the hole and pin it in this position. Under the low power of the microscope, the movement of blood cells through capillaries and perhaps arterioles can be seen. Arterioles may be identified by their slight pulsation.

Hemoglobin Determination

The Tallquist-Adams method for making hemoglobin determinations, though not highly accurate, does identify gross hemoglobin insufficiency. Wipe the tip of the middle finger with rubbing alcohol or 70 per cent ethyl alcohol. When the finger is perfectly dry, make a small puncture (in the fleshy part of the fingertip) with a sterile needle. The puncture should be deep enough so that a drop of blood forms at once without squeezing the finger.

Blot the blood with a square from the Tallquist book and compare the color immediately with the scale in the book. The number read from the scale is a percentage. One hundred per cent is the equivalent of 15.9 grams of hemoglobin per 100 milliliters of blood. The count in grams per 100 ml. can be obtained from the following relationship:

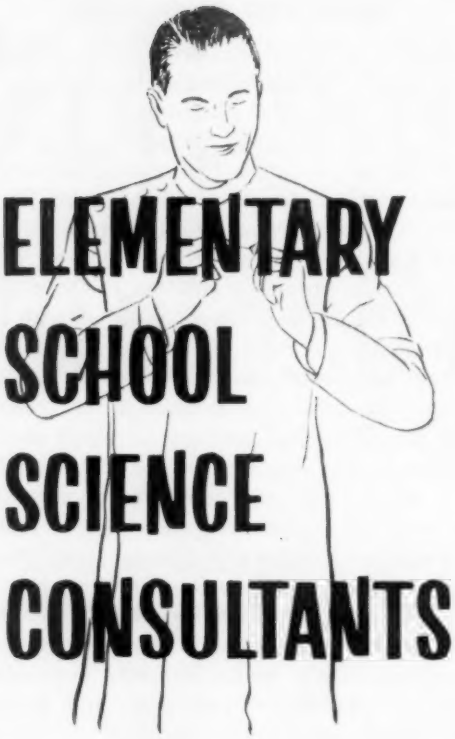
$$15.9 \text{ g.}/100 \text{ ml.} = x/\text{percentage from scale.}$$

Blood Pressure

Blood pressure measurements in man are made by an indirect method which uses a sphygmomanometer. Wrap the cloth part of the instrument around the bare left arm just above the elbow. Be sure that the inflatable rubber bag is on the inside of the arm. Attach the manometer to the

(Continued on page 294)

Needed: ELEMENTARY SCHOOL SCIENCE CONSULTANTS



By J. MYRON ATKIN

Assistant Professor of Education, College of Education, University of Illinois, Champaign

AN increasing amount of research indicates that the elementary school is the logical starting point for a strong science program—both for purposes of general education and vocational choice. It has been found that deep science interests characterize the very young, that even preschool children can comprehend a range of significant science concepts, that career choices about science are often made before the age of 12, and that, with a strong elementary school science program, secondary school science curricula can be upgraded sharply.

This need to begin an effective science program in the elementary school is now widely recognized. But, despite this recognition, it is also generally agreed that elementary school science instruction is not as strong as it might be. Many elementary school teachers feel inadequate in teaching science. The training they presently get in the science area as undergraduates is generally weak. Few colleges require a course in teaching elementary science of prospective teachers. Most elementary school teachers are poorly prepared in the science content fields, as well. While there are notable exceptions to these generalizations, few would deny there is vast room for improvement in elementary science instruction.

Appreciating the need for upgrading elementary science programs, school systems and teacher education institutions have initiated several methods of curriculum improvement. Common is the workshop in science for elementary teachers. At these sessions, one or more specialists in elementary science are brought in from outside the school system to work with teachers. The best workshops are held for several days during which time there is opportunity for the teachers to manipulate science materials, raise specific questions about improving the science program, and, thereby, gain a greater feeling of confidence in the science area. Workshops are sometimes scheduled before the start of school in the fall. Often they are held during the school year when children are released from classes.

Patterns of Curriculum Improvement

Increasingly, teacher education institutions are revising their curricula to include an undergraduate course on teaching elementary science. In at least one institution, a curriculum has been established whereby an elementary education major may specialize in science at the undergraduate level.[1]

[1] Walter A. Thurber, "Training Elementary Teachers with a General Science Specialty," *School Science and Mathematics*, Vol. 50, Oct. 1950, pp. 553-559.

In a number of large school systems, supervisory personnel have been hired to give primary attention to elementary science. These supervisors may work in a sizable section of a large city with responsibility for curriculum improvement in 50 schools.

Each of these general methods for the systematic upgrading of elementary science instruction has value. Workshops serve to focus attention on the science program. More intensive pre-service programs give new teachers greater confidence in teaching science. Supervisors working with large numbers of teachers can help give direction to the curriculum improvement efforts.

But each of these methods has limited value in view of the monumental job that must be done. Workshops are seldom a source of *continuous* curriculum revision in a given area. Outside specialists are helpful and inspiring, but their effect is often short-lived. There may be a short period of increased emphasis on the science program, but it is usually only temporary. Without constant encouragement, help, and suggestions tailored to the individual teacher's needs, there is often only limited improvement in science teaching.

A single course on teaching science in the elementary school helps. But science is a rapidly changing field. Classroom teachers need assistance to meet new problems that always arise both in science teaching practices and the field of science itself.

Supervisors in elementary science frequently work with so many hundreds of classroom teachers, that their efforts are largely directed toward the preparation of written curriculum aids. While they also conduct meetings with key school personnel to encourage greater attention to elementary science, face-to-face contacts with teachers are restricted because of the large numbers.

A New Curriculum Worker

To meet the need for improved elementary science programs, several school systems have employed a relatively new type of curriculum worker—the elementary school science consultant. This individual serves as a full-time resource person to classroom teachers in an effort to improve elementary school science teaching from grades kindergarten through six.

It is recognized in school systems using the consultant approach that a single science consultant working with hundreds of elementary school children cannot possibly appraise the science needs, level, and interests of the youngsters in each classroom. Also, it would be unrealistic for him to prescribe a single pattern of science teaching that meets the curriculum orientation of each of the classroom teachers with whom he works. The job of planning the *total* curriculum framework is left ultimately to the classroom teacher in keeping with modern elementary school practice. The consultant works to improve the teacher's competence in teaching science, but he does it within the framework of each individual classroom teacher's curriculum orientation.

The Double Role

Thus the science consultant acting as a resource person might give several different types of assistance. To the classroom teacher who feels competent in elementary science and who has a rich science content background, he might only furnish equipment, books, and an occasional suggestion. For the teacher who feels completely inadequate at first when working with children in the science area, he might do all the science teaching while the classroom teacher watches him work with the children. Through such demonstration teaching, the classroom teacher might begin to feel more competent and gradually take greater responsibility for the teaching of science.

Generally, the science consultant improves the quality of science instruction through procedures such as these: demonstration teaching, developing printed curriculum aids, conducting workshops in elementary science for teachers, holding individual planning conferences with teachers to make suggestions for improvement of the science program, ordering and storing science equipment and books, and working with administrators in helping them to see the importance of science in the total curriculum.

One school system has described the work of its science consultants as follows:

"——AS A RESOURCE PERSON

- . . . helping to plan ways for science to enter into classroom experiences
- . . . where there is a definite science interest in the classroom, and the teacher does not feel sure how to develop this interest, the consultant will help the teacher to discover directions in which to proceed
- . . . to suggest ways that illustrative and reference material, demonstrations, and science equipment may add vitality to learning situations
- . . . to help meet sudden science problems that arise
- . . . to suggest places that may be visited in connection with science activities in the classroom
- . . . to prepare occasional leaflets and helps on current, pertinent science topics
- . . . the science consultant will conduct workshops, demonstrations, and experiments which may

give classroom teachers interest-provoking experiences that they may wish to take back to the children

"——AS A CO-TEACHER (in all cases, co-teaching should be preceded by a conference with the classroom teacher).

. . . If a science project is under way and the teacher feels that further development of the topic will be useful, the science consultant will work directly, teaching the class.

. . . In some instances, the science consultant will be pleased to initiate a science "unit," *if* there is an interest or need in the classroom and the teacher feels help is needed in starting.

. . . If a teacher has a small group or a single child with a special interest, plans can be made for the group or child to work with the science consultant, apart from the class.

. . . The science consultant will gladly work with a group of children preparing a science demonstration or experience which they'd like to take back to the classroom.

. . . The science consultant will always enjoy the opportunity to work with the class in planning for a new science area."[2]

What Does a Science Consultant Do?

Here are several examples of various methods in which science consultants may work with classroom teachers:

"In a first grade, a puppet stage had been constructed in shop. The children desired to have footlights 'like the real stage in the auditorium.' The science consultant was called in, and, working with an interest group, wired the puppet stage for lights.

"A fourth-grade class had been given physical examinations by the school physician. The children showed a great interest in their bodies following this and expressed a desire to learn more about the human body. The classroom teacher was interested in going further and talked the situation over with the science consultant. Together, they planned a series of science lessons, taking up the different functions of the body. From this, the class made a study of proper foods and diet.

"A sixth-grade group had been studying the materials that make up the earth. They had gone into elements, compounds, and mixtures. The teacher then called upon the science consultant for help. The science consultant worked with groups from the class. One group collected samples of elements and compounds. Another worked out experiments which showed chemical and physical changes. Another group discovered through experiment that new compounds may be made by combining, and that compounds may be broken down into elements. With high interest, the children took these demonstrations back to the whole class.

"A third-grade youngster, new to the school, adjusted very poorly to the group. He played alone and was largely ignored by others. The teacher discovered that his only sustained interest was in the collection of insects. The science consultant, at the suggestion of the classroom teacher, worked with the boy alone, since this was not a need of the entire class. The boy learned to kill, identify, and mount insects. His collection was a source of great interest to the whole class. The boy became a more acceptable group member. This experience not only served to stimulate a specific intellectual activity, but helped to start him on cooperative work with others.

"A sixth grade became interested in electrical fuses in connection with a larger unit on safety. A pupil committee worked with the science consultant to build a demonstration model of a fuse. The committee then reported back to the group and gave a demonstration of a short circuit, using materials that were safe to handle. They showed the class what makes a fuse blow out and how the fuse protects homes and people.

"A first-grade teacher wanted to work with her pupils in science. Not having a definite idea of where to begin, she came to the science consultant. They talked about the things the children brought in and planned work in electricity for the group since a lamp was being built for the room, and several children had indicated an interest in flashlights."[3]

In-Service Curriculum Workers

Thus most school systems that employ science consultants utilize them as in-service curriculum workers. They recognize that the consultant is working to improve the competence of the individual classroom teacher rather than serving as the science teaching department himself.

To serve as resource person in the manner outlined above, the science consultant should probably work with no more than 50 classroom teachers of children in grades kindergarten through six. A smaller load is preferable, and a few small schools actually have a load of one science consultant to eight or nine classroom teachers. However, there is no research at present that indicates an optimum ratio of science consultant to teachers.

Relatively few elementary school teachers have a science consultant whom they can call on for help. Undoubtedly one reason why science consultants are not employed more extensively at pres-

(Continued on page 300)

[2] J. Myron Atkin and Tracy Ashley, "How About Science." Great Neck, New York, Public Schools, 1951. 4p.

[3] *Ibid.*

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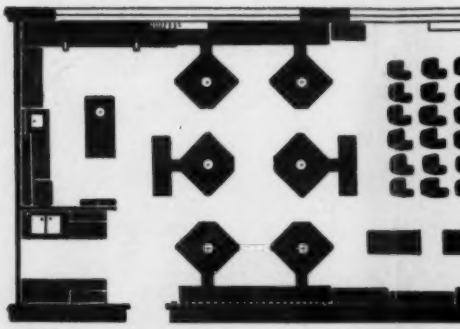

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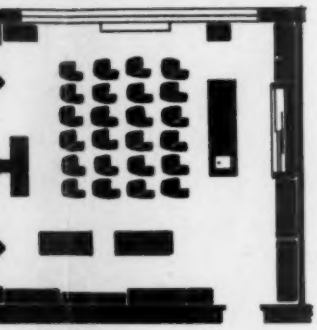

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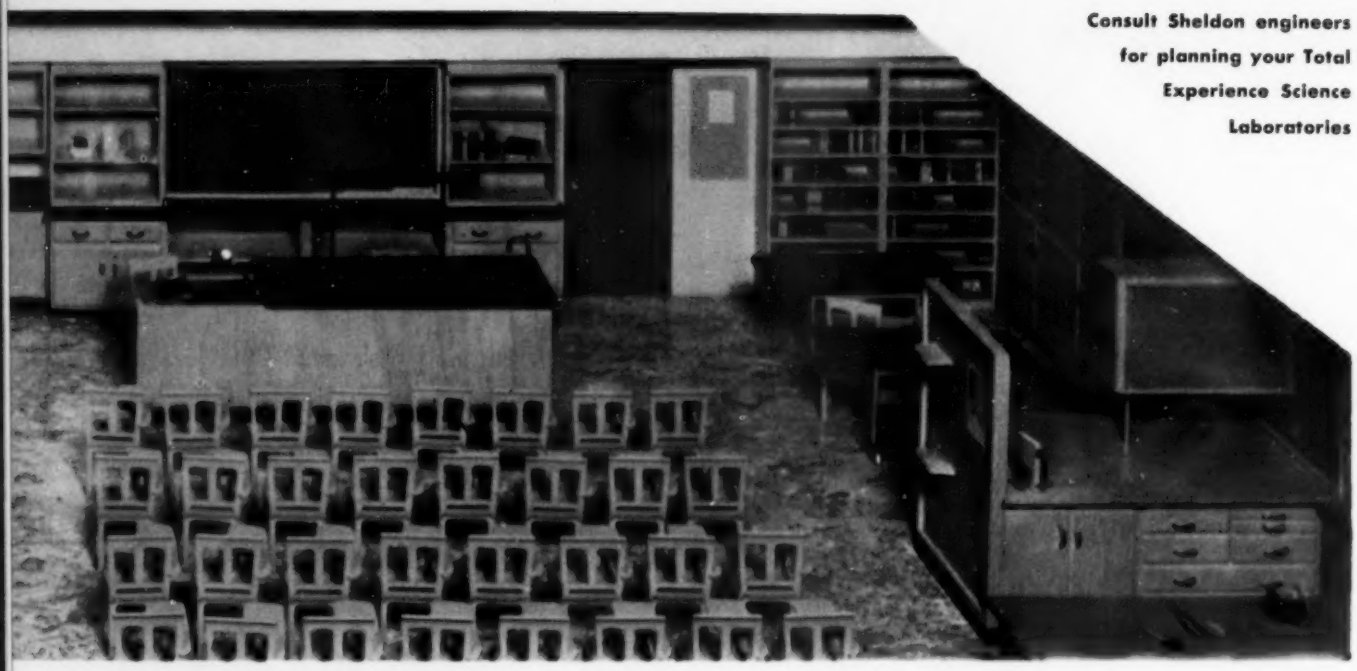

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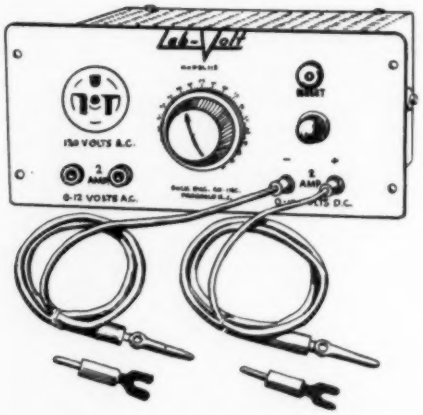

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A STUDY OF ACADEMIC PREPARATION OF THE SECONDARY SCIENCE TEACHERS OF KANSAS

By MERLE E. BROOKS and WELDON N. BAKER

Kansas State Teachers College, Emporia

AVAILABLE EVIDENCE indicates that little is known concerning the academic preparation of the science teachers of the nation. The teachers of science may be called upon to teach not only biology, chemistry, physics, and general science, but one or more nonscience courses as well. Since a wide variety of course combinations are taught by the science teacher and a great deal is being done to improve the academic preparation of the science teachers of the nation, we felt it expedient to study the background and preparation of the science teachers of Kansas.

The present study is a report on the science teachers of Kansas, their academic preparation in individual course work, degrees, employment, age, salary, and high school origin. Every teacher teaching any science course is included. It is hoped that this study will serve as an impetus to further studies in other states.

The data were obtained from the 1955-56 High School Principal's Organization Reports on file at the State Department of Education, and from the transcripts which are on file in the same department. Transcripts not available at the State Department were studied at the Registrar's Office of various colleges in the state. There were 1177 teachers of science; transcripts were found for 1144 which form the basis for this report.

For the school year 1955-56, 650 senior high schools and 57 junior high schools were accredited by the State Department of Education. The present study covers data from all the senior and junior high schools in Kansas.

Employment and Experience

Kansas has many small rural communities; therefore, it was not surprising to find that 46 per cent of the science teachers were employed in schools with an enrollment of less than 100 pupils, and over one half, or 52 per cent, were teaching in communities with a population of less than 1000 people. Eleven schools were found to be teaching no science at all. This situation might be due to the fact that their science courses were alternated with some nonscience courses; for example, general science one year and mathematics the next.

With a population increase and more young people entering the secondary schools, there has been an increase in the number of science teachers in Kansas. The increase was from 792 in 1946 to 1177 in 1956. Fifty three per cent of the teachers of science had less than nine years of teaching experience and 49 per cent of the teachers were under 36 years of age. Sixty per cent of the teachers had less than four years of experience in their 1955-56 positions. It may be noted for comparison that 29 per cent graduated from college during the period 1951-55 and 24 per cent more graduated between 1946 and 1950 (Figure 1). This is a total of 53 per cent in the last ten years.

Seventy per cent of the science teachers graduated from Kansas high schools. The high schools in the various-size cities furnished science teachers approximately in proportion to their school enrollment except for the cities having more than 50,000 population. The schools in these large cities with 25 per cent of the secondary enrollment in the state and requiring 145 science teachers, supplied only 64 teachers. The Kansas cities that produce

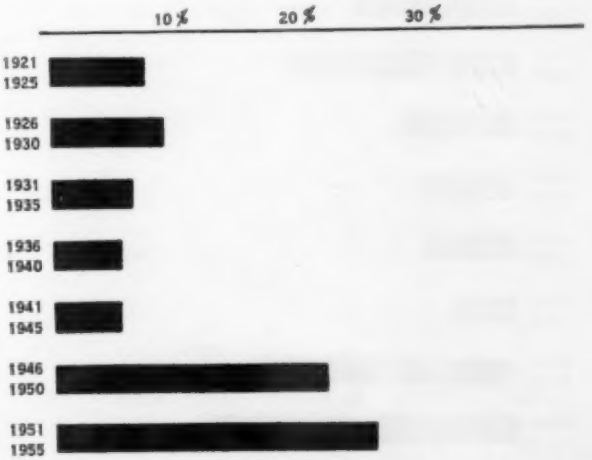

FIG. 1. DATE OF RECEIVING BACHELOR'S DEGREE

EDITOR'S NOTE: This article represents the kind of study that, in the editor's opinion, is needed to help eliminate many of the uncertainties that create the present atmosphere of concern regarding science teaching. A study of this type reveals what the facts are; it substitutes reliable information for lack of knowledge and assumptions growing therefrom. It provides a basis for action in determining the facts about the science teaching profession.

Many states are now making this kind of study; others should undertake them. This article is published in *The Science Teacher* not as a model for such studies, but as a guide. It is only reasonable that the design of each study must vary in line with the particular conditions and problems in each state. While the National Science Teachers Association hopes each state will make a study of this type, it would of course be impractical to attempt to publish each one in this journal.

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more than their requirement of science teachers are the cities with a population between 10,000 and 20,000.

Salaries

The median annual salary of the science teachers of Kansas was $3900 (Figure 2). The highest salaries were paid to the administrators who taught some science and to the experienced teachers in the larger cities. Many new teachers began their science teaching careers close to or above the median salary.

Academic Majors

The general education requirements for a teaching certificate in Kansas are ten hours of science, covering both physical and biological science. The certification requirements for science teachers in Class A schools in Kansas are 24 hours in the field of science and six hours in the science subject taught. Thus, anyone taking an additional 14 hours in science above his general education requirement is eligible to teach science.

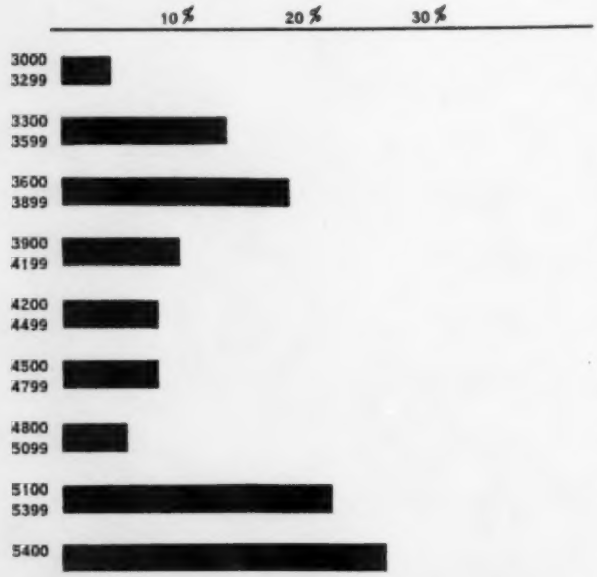

FIG. 2. ANNUAL SALARY OF SECONDARY SCIENCE TEACHERS

Table I shows that there were 169 physical education majors, 96 home economics majors, 86 mathematics majors, 51 industrial arts majors, and 41 social science majors teaching science in Kansas. Among those who majored in science, there were 157 biology majors, 90 majors in general and physical science, 84 majors in chemistry, and 26 majors in physics. In analyzing the major teaching fields in respect to the age of the teacher, it was found that those teachers of science who majored in physical education were a young group with 141, or 83 per cent, of the 169 under 35 years of age. Most other groups had close to the same number over 35 years of age as under 35.

TABLE I

Academic Majors Versus Age

Age of teachers			20–35		36–	
Number	1014		516		498	
Major	No.	%	No.	%	No.	%
Administration	89	7.9	18	3.5	62	12.4
Biology	157	15.5	75	14.5	82	16.5
Science (general, physical)	90	8.9	42	8.1	48	9.7
Chemistry	84	8.3	35	6.8	49	9.9
Physics	26	2.6	18	3.5	8	1.6
Other sciences (zoology, etc.)	27	2.7	14	2.7	13	2.6
Agriculture	37	3.6	12	2.3	25	5.0
Physical education	169	16.6	141	27.4	28	5.6
Home economics	96	9.4	36	7.0	60	12.1
Mathematics	86	8.5	53	10.3	33	6.6
Industrial arts	51	5.0	26	5.0	25	5.0
Social science	41	4.3	18	3.5	23	4.6
Other nonscience majors	70	6.7	28	5.4	42	8.4

Read table thus: The academic major was ascertained for 1014 teachers. Of these, 157, or 15.5%, were biology majors. Of the biology majors, 75 were between the ages of 20 and 35. This is 14.5% of the 516 in that age range.

Seventy nine per cent, or 909, teachers of science were graduates of Kansas colleges. Of these, 347 were graduates from the three colleges in the state which were primarily interested in teacher training. Graduates from the independent colleges totalled 292; from Kansas State College and the University of Kansas, 218. Fifty-two were graduated from the two municipal universities located in Kansas.

Table II shows that the three Kansas teacher training institutions with a total enrollment of approximately 6000 students produced 126 teachers with a major in one of the sciences. The University of Kansas and Kansas State College, with a total enrollment of approximately 15,000 students, produced 74 teachers with a major in science. The 14 independent colleges, with an approximate enrollment of 6000 students, pro-

TABLE II

Academic Major in Science by College From Which Graduated

Major	Total Number	Three Kansas State Teacher Training Institutions	University of Kansas and Kansas State College	Fourteen Independent Kansas Colleges	Outside State
Biology	157	56	21	58	22
Science (general, physical)	90	22	16	28	24
Chemistry	84	15	13	40	16
Physics	26	16	3	4	3
Other sciences (zoology, etc.)	27	3	11	7	6
Agriculture	37	14	10	2	11

Read table thus: Of the 157 biology majors, 56 were graduated from state teachers colleges, 21 from other state supported schools, and 58 from independent colleges.

duced 139 teachers with majors in science. These data show that the small independent colleges and the teachers colleges produce a large number of the science teachers in Kansas.

Academic Preparation

Since there is no universal agreement as to the academic preparation and subject matter competence of the science teacher, we have arbitrarily chosen what we consider the ten basic science courses essential for the effective teaching of science.

Table III shows the "basic ten" and gives the number and per cent of the teachers with credit in the respective subjects. With the exception of field biology and modern physics, they represent the courses most frequently taken in the preparation for science teaching. Qualitative analysis was included with chemistry II since in many schools qualitative analysis follows chemistry I.

The college courses taken most frequently by the group as a whole were chemistry I (71%), zoology (55%), physics (51%), and chemistry II (50%). The general science teachers and the junior high science teachers had essentially the same preparation as the entire group.

On the basis of these particular courses, the chemistry teachers showed up best. Ninety six per cent have had chemistry I, 80 per cent chemistry II, and 56 per cent organic chemistry. Seventy one per cent have had physics I, 55 per cent physics II, and 53 per cent zoology.

The physics teachers showed about the same preparation in both first year physics and first year chemistry. Eighty four per cent had physics I and 66 per cent physics II; 83 per cent had chemistry I and 66 per cent chemistry II. The physics teacher's preparation in the biological sciences was below the average of the whole group.

Of the biology teachers, 66 per cent had credit in zoology, 58 per cent in botany, and 47 per cent in general biology. In some schools general biol-

TABLE III

Teachers Grouped by Subject Taught Having College Credit In Ten Basic College Science Courses

	All Science Teachers		General Science Teachers		Biology Teachers		Chemistry Teachers		Physics Teachers		Junior High Science Teachers	
Number of Teachers	1144		488		539		225		251		131	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
General biology	486	43	215	44	254	47	83	37	101	40	52	40
Botany	533	47	225	46	310	58	100	45	91	36	68	52
Zoology	627	55	263	54	358	66	120	53	116	46	80	61
Field biology	123	11	49	10	72	13	27	12	28	11	17	13
Chemistry I	810	71	336	69	368	68	215	96	208	83	87	67
Chemistry II	571	50	224	46	249	46	179	80	166	66	65	50
Organic chemistry	302	27	123	25	147	27	125	56	81	32	29	22
Physics I	579	51	227	47	240	58	159	71	210	84	57	44
Physics II	395	35	154	32	159	30	123	55	166	66	32	24
Modern physics	46	4	16	3	16	3	15	7	24	10	3	2

Read table thus: 225 science teachers were teaching chemistry. Of these, 159 or 71% had Physics I.

TABLE IV

Teachers Who Had No College Credit in General Biology, Botany, or Zoology

Science Teachers	Total	Number Without Credit	Per Cent Without Credit
All science teachers	1144	188	16.4
Biology teachers	539	41	7.6
General science teachers	488	86	17.7
Junior high science teachers	131	18	13.7

Read table thus: Of the 1144 science teachers, 188, or 16.4 per cent, had *no* credit in general biology, botany, or zoology.

ogy is actually a course in zoology and botany. This made it difficult to determine whether or not a given individual had actually taken zoology and botany. Table IV lists the teachers who had no college credit in any of the following courses: general biology, botany, or zoology. Forty one, or 7.6 per cent, of the biology teachers and 86, or 17.7 per cent, of the general science teachers did not have general biology, botany, or zoology.

TABLE V

Course Combinations

Course Combinations	Number of Teachers
ONE COURSE	
Biology	229
General science	200
Junior high science	98
Physics	83
Chemistry	59
Others (zoology, physiology, etc.)	20
TWO COURSES	
General science and biology	143
General science and physics	32
Biology and chemistry	32
Chemistry and physics	26
General sicence and chemistry	19
Biology and physics	17
Biology and others	23
Physics and laboratory science	4
General science and laboratory science	4
Other two course combinations	20
THREE COURSES	
General science, biology, and chemistry	25
General science, biology, and physics	25
Biology, chemistry, and physics	13
General science, chemistry, and physics	11
Other three course combinations	30
FOUR COURSES	
General science, biology, chemistry, and physics	19
Other four course combinations	11

Read table thus: 229 teachers were teaching biology as their only science course. They may be teaching other nonscience courses.

Table III also shows the number of teachers teaching a given science subject. Many of them were teaching other science or nonscience courses as well. The largest number, 539, were teaching biology. Four hundred and eighty eight were teaching general science, 251 were teaching physics, 225 were teaching chemistry, and 131 were teaching junior high science.

The course combinations taught by science teachers are given in Table V. Where only one or two science courses were offered in the school, the teachers were assigned to teach several nonscience courses. In other cases, the principal was teaching a science course. Six hundred and eighty nine teachers were teaching one science course only. This should not be interpreted to mean that there were 689 science teachers teaching science full time; actually, there were fewer than 50 full-time biology teachers, fewer than 10 full-time chemistry teachers, and even a smaller number teaching full time in physics. Two hundred and twenty nine of these taught biology as their only science subject. A similar situation was true in general science where 200 were teaching general science as their only science subject. Eighty three taught physics only and 59 taught chemistry only. Three hundred and twenty were teaching two different science courses. The most common combination was general science and biology with 143 teachers. One hundred and four teachers taught three science courses and 30 taught four courses.

These data will be published in more detail in the Emporia State Research Studies, the graduate publication of the Kansas State Teachers College, Emporia.

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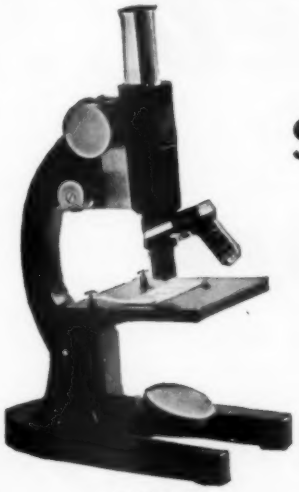

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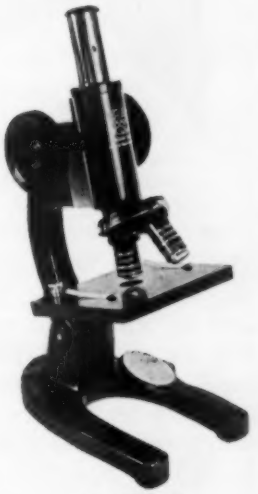

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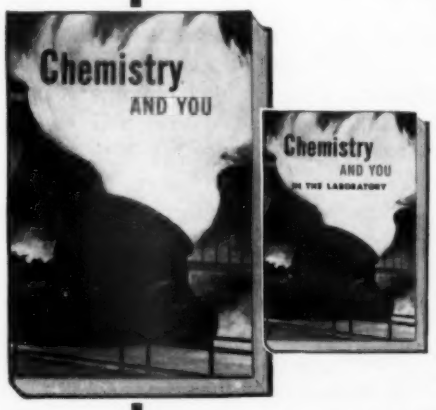

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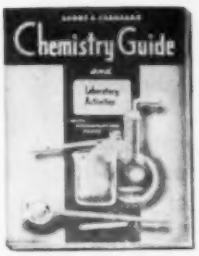

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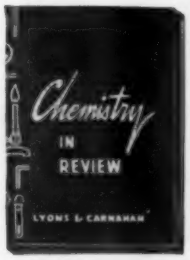

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WANTED . . . More Ideas in Science Teaching

Thanks to a new—and larger—grant from the U. S. National Cancer Institute, there's a second chance to "hitch your wagon to a STAR."

For the second successive year, the National Science Teachers Association will conduct the Science Teacher Achievement Recognition (STAR) awards program under an NCI grant. The 1957-58 program is an expanded one, providing cash awards totaling $6750 to 50 teachers in place of the ten cash awards totaling $2000 in the 1956-57 program. This year STAR has a specific theme; awards will be made for reports of effective practices in the laboratory teaching of science. The reports are to be submitted with details on how the ideas have been carried out in the classroom and laboratory.

Junior and senior high school science teachers and supervisors in public, private, and parochial schools are eligible to enter. NSTA membership is not a prerequisite.

The deadline for the new program is February 15, 1958. ***Entries must be postmarked not later than this date.*** Entry blanks are now available at NSTA headquarters on request; the address is 1201 Sixteenth Street, N. W., Washington 6, D. C.

These are the awards to be made in the 1957-58 program: $500 each to five science teachers; $250 each to ten teachers; and $50 each to 35 teachers. Each cash award winner will also receive a bronze medallion and a trophy case plaque for his or her high school. A STAR certificate of participation will go to all entrants.

From the long-range viewpoint, STAR is designed to increase the supply of critically-needed young scientists by improving high school science teaching techniques. In announcing the 1957-58 program, Robert H. Carleton, NSTA Executive Secretary, said that its goal is "to locate successful and promising plans for improving laboratory teaching in junior and senior high schools. Laboratory work," he pointed out, "is being emphasized this year because not enough young science students are getting the satisfactions and experiences of real discovery in science.

"This can sometimes be attributed," he continued, "to over-crowded, ill-equipped classrooms and outmoded laboratory exercises that in no way reflect new developments or the 'problem-solving' approach. We know, however, that there are effective teachers who are doing a good job under less than perfect circumstances. We hope they will share their ideas with others through STAR."

As in the previous program, a cross-section of reports from the winning entries will be published in a special brochure to be distributed by NSTA next year. "Through this brochure," Mr. Carleton said, "thousands of teachers will be able to read about, study, and put into practice the ideas of

pioneering science teachers whose work needs to chain-react throughout the schools of the nation."

There are no specific physical requirements for entries. Typed, double-spaced reports are, of course, more readable. Clear, sharp photographs which tell a story and effective drawings can make a report more graphic. In the new program, only one copy need be submitted in place of the original and duplicate asked for in the 1956-57 program.

There are no restrictions on the *content* area of STAR entries just as long as they relate to laboratory-type teaching. The information and materials to be sent to STAR applicants will include data on cancer programs should entrants wish to select this field. However, as was demonstrated in the list of 1956-57 STAR winners, the ingenuity and practical worth of the teaching ideas reported are the basis for judging the award winners rather than the content area.

Entrants are advised to spell out any necessary safety precautions in laboratory practices. Reports should also reveal that modern humane handling and care of animals have been provided for in any experimentation in which they have been used.

More than 300 entries were received in the 1956-57 STAR program. The national committee for the 1957-58 program anticipates a considerable jump in the number of entries due to the interest and excitement generated after the first STAR awards were announced. Part of this came from national publicity and a great deal of it from the publication of articles in *The Science Teacher* as well as of the 1956-57 brochure, "STAR Ideas in Science Teaching."

The group directing the 1957-58 STAR program consists of:

Advisory Committee: Dr. John R. Heller, *Director*, National Cancer Institute, Bethesda, Maryland; James F. Kieley, Chief, Public Relations and Public Information, NCI; Dr. Israel Light, U. S. Public Health Service, Washington, D. C.; and Dr. Ellsworth S. Obourn, U. S. Office of Education, Washington, D. C.

National Operating Committee: Director, Robert H. Carleton, NSTA; *Secretary-Editor*, Dr. Abraham Raskin, Hunter College, New York City; Dr. Murray Copeland, School of Medicine, Georgetown University, Washington, D. C.; Dr. Ross C. MacCardle, Laboratory of Pathology, National Institutes of Health; Spencer Mapes, American Cancer Society, Inc., New York City; Dr. Margaret J. McKibben, Oak Park and River Forest High School, Oak Park, Illinois; Miss M. Polk Roberts, Towson, Maryland, Senior High School; Dr. Emma Shelton, NCI; George Taylor, Wakefield Junior High School, Arlington, Virginia; and Kenneth E. Vordenberg, Supervisor of Science, Cincinnati, Ohio, Public Schools.

New in Science

Vital readings for the International Geophysical Year, 1957-58

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Classroom Ideas

General Science

A Magnetic Board

By DANIEL BRANDON, Junior High School 79, Bronx, New York City

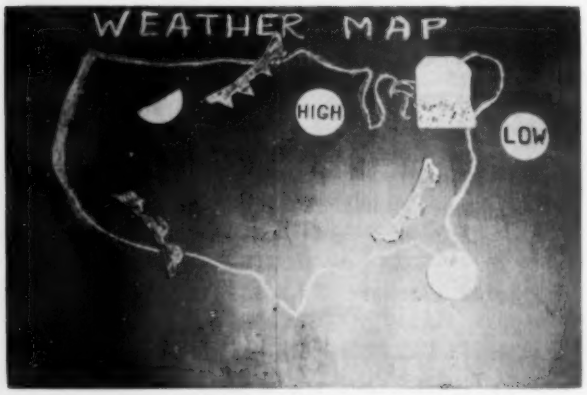
EDITOR'S NOTE: *This Classroom Idea was one of the entries submitted in the 1956–57 STAR (Science Teacher Achievement Recognition) awards program.*

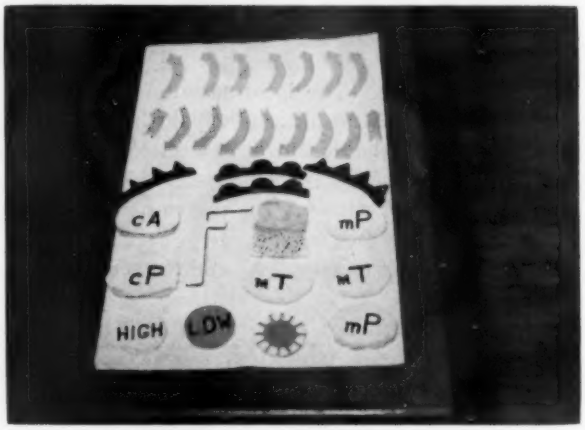
An interesting device which can be put to many uses is a magnetic board. This can be easily constructed in the shop of any junior or senior high school. The size can be made to vary with the need but I suggest a minimum of two feet by three feet.

Secure a piece of plywood about ⅜-inch thick and cover one surface with sheet iron. Metal hooks should be attached in order to hang the board either in vertical or horizontal position. A half pint of blackboard paint costing less than one dollar can usually be secured through a local dealer. Paint the metal surface of your board with this slate paint. When it is dry you can write with chalk and erase as on a blackboard.

Next comes the construction of the accessories which are used in conjunction with teaching a particular unit. The accessory pieces are cut from plywood with a coping saw. Secure small alnico magnets about one-inch long and ¼-inch wide. Gouge out enough layers of plywood to insert the magnet level and secure with "airplane" cement. Each accessory must have its own alnico magnet. Some of them may need two. The accessory, if not too big, will stick to any part of the metal surface of the board.

Accessory pieces used in conjunction with the weather unit.





Accessories used to demonstrate some features of a weather map.

The uses to which I put my board include:

I. Weather Unit
   - A. To teach air masses and their movements.
   - B. To show a typical low and typical high pressure area.
   - C. To demonstrate the movement of "highs" and "lows" in the United States.
   - D. To indicate important features on a weather map such as fronts, rain, partly cloudy, sunshine, and location of air masses.

II. Atomic Energy
   - A. To show a simple hydrogen atom of one proton with one electron spinning around it.
   - B. To construct other nuclei of other elements such as helium, lithium, beryllium, carbon, nitrogen, boron, and oxygen.
     (The neutrons may be painted green to indicate no charge and protons, red, to indicate positive charge.)

The degree to which this device can serve a teacher is limited only by imagination and ingenuity.

Physics

Surface Tension

By VERDINE E. TROUT, Physics Teacher,
Sand Springs, Oklahoma, High School

An accurate and inexpensive apparatus for determining the surface tension of liquids can easily be made in any high school physics class. The materials needed are two thermometers, a large test tube, and a small test tube with stoppers.

Procedure:

(1) Cut the ends off one of the thermometers and remove the mercury. This will serve for a capillary tube of very fine bore. Determine the equivalent calibrations in centimeters.

To determine the radius of the capillary weigh the tube, fill a portion with mercury, and measure the length and the weight of the mercury. Calculate the radius of the capillary from the length of the column of mercury, its weight, and the density of mercury.

(2) Assemble the apparatus as shown in Figure 1.

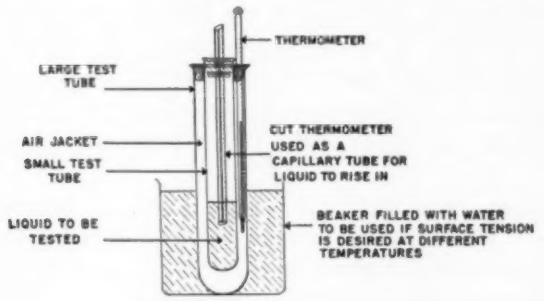

THERMOMETER
LARGE TEST TUBE
AIR JACKET
SMALL TEST TUBE
CUT THERMOMETER USED AS A CAPILLARY TUBE FOR LIQUID TO RISE IN
LIQUID TO BE TESTED
BEAKER FILLED WITH WATER TO BE USED IF SURFACE TENSION IS DESIRED AT DIFFERENT TEMPERATURES

FIGURE 1

(3) To determine the surface tension of a liquid use the following formula and refer to Figure 2.

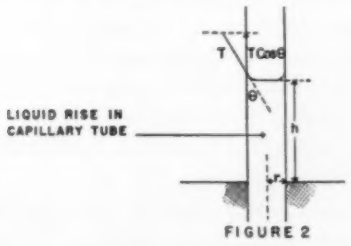


FIGURE 2

$$T = \frac{rdgh}{2 \cos \Theta}$$

T—Surface tension in dynes
r—Radius of capillary in centimeters
d—Density of the liquid
g—Value of gravity 980
h—Height of liquid rise in tube
Cos Θ—For all practical purposes is 1

(4) With the apparatus assembled as in Figure 1, surface tension measurements may be taken at different temperatures. The air jacket enables a relatively constant temperature to be maintained.

Chemistry

Glass Tubing and Stoppers: You Don't Have to Fight Them

By CHARLES D. DRAYTON, JR., Science Curator,
Brooklyn Children's Museum, Brooklyn, New York

Seriously damaged hands can result from forcing tight-fitting glass tubing in or out of stoppers. Many laboratories throw away stuck tubing. Another procedure has been to wet the stopper and tubing and to apply force through a towel so broken glass will not cut the experimenter.

An easier, safer, and cheaper method is to find a cork borer into which the tube will fit as snugly as possible. To remove the tube from the stopper, apply water and soap, if necessary, to the borer. Then slide the borer onto the tube and twist it into the stopper hole around the tube. When the borer is completely through the stopper, the tube will slide out easily.

To get overly-snug tubing into a stopper, insert the cork borer into the stopper. Then slide the tubing inside the borer to the desired position. Hold the tubing and stopper in this position while removing the borer.

It is not always possible to find borers for all sizes of tubing and stoppers, but relations between tubes, stoppers, and the laboratory worker will be greatly improved by using the suggested method.

Elementary Science

Town Names in Science Teaching

By DONALD H. LOKKE, University of Kansas, Lawrence

If a group of science teachers were asked to name a town, they probably would consider the name of a familiar plant, animal, or nearby natural feature. The same line of thought was followed by the founders of many of our communities. Buffalo, Kansas, is an example of such a choice. Some towns named for people bring to mind an object of nature; Bird City, Kansas, is one of these towns.

The close association between nature and early community life provides a fascinating way for children to learn about objects of nature, while at the same time they become acquainted with maps

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The "City Limit" sign at Buffalo, Kansas is a reminder of how many U. S. cities and towns were named as a result of their plant, animal, or other science-related backgrounds.

and regional geography. Given a set of maps for any state they will eagerly search for as many natural features as they are able to find. Town names reflect animals, plants, rocks, streams, and weather. While enjoying this activity they will become aware of many new natural features and see regional variations in the selection of names.

This list of a few Kansas towns, taken from a road map, will show the possibilities:

BIRDS—Bird City, Partridge, Redwing.

OTHER ANIMALS—Buffalo, Elk City, Deerfield, Wolf, Bison, Beaver.

TREES—Burr Oak, Ash Valley, Cedar, Willowdale, Walnut, Maple City, Oakhill, Lone Elm, Cottonwood Falls.

OTHER PLANTS—Maize, Oatville, Rice.

WEATHER AND SEASONS—Spring Hill, Summerfield, White Cloud, Windhorst, Sunnydale, Rainbow Bend.

ASTRONOMY—Orion, Zenith, Sun City.

ROCKS AND MINERALS—Gypsum, West Mineral, Silica, Galena, Diamond Springs, Emerald, Radium, Salt Fork, Salina, Carbondale, Rock, Silver Lake, Silverdale.

WATER FEATURES—Clearwater, Coldwater, Silver Lake, Lost Springs, Fall River, Little River, Overbrook, Blue Rapids, Neosho Falls.

COUNTRYSIDE FEATURES—Pleasant Valley, Valley Center, Hill City, Hilltop, Plains, Highland, Prairie View, Pretty Prairie.

Children also may be referred to lists of animal, tree, and bird town names by Harry W. Githens in *Nature Magazine* (Nov. and Dec. 1954, Mar. 1955).

The "Mile-High City" it's called—and it's a mecca for vacationists and tourists from all parts of the country. It's Denver, Colorado, of course; a beautiful city, combining altitude, clear air, sunshine, and breathtaking mountain vistas. Nestling in the foothills of the Rockies, it's a city that most Americans long to visit, or revisit.

The opportunity to do either is what is in store for NSTA members next March. Denver is the site of the Association's 6th National Convention, which will meet in the Colorado capital from Wednesday, March 26 through Saturday midday, March 29.

The theme of the Denver convention is a vital one for science teachers: *Improving Classroom Science Instruction.* For more than a year now, the convention committee has been giving painstaking attention to working out a program which will make this theme meaningful. It will be given practical application and it will be highlighted by curbstone clinics, field trips, demonstrations, discussions of student projects, and the always crowded exposition of science teaching aids.

The theme will also be related to current events. The topic of the annual banquet—on Thursday evening—will, for instance, be the most timely and significant of modern science explorations, the International Geophysical Year.

Programwise, the convention theme will be carried out by a study of major problems. Following each speech on a particular problem, the discussion groups will divide into three sections—for college, elementary, and secondary school science teachers. The scheduling of special sections for college teachers is an innovation in NSTA convention programming.

These are the problems to be taken up at the various sessions: Wednesday afternoon, "What constitutes effective science teaching?" Wednesday evening, "What constitutes an effective science program?" to be followed by a symposium on "How can each level of science teaching contribute to the effectiveness of the total science program?" Thursday morning, "What are the characteristics of a good science teacher?" Friday morning, "How can we improve classroom instruction through research in teaching?" Friday afternoon, "How can we use the knowledge of current science to improve science teaching?" Saturday morning, "What constitutes effective use of instructional materials in science teaching?"

Thursday afternoon has been set aside for the tours and field trips, including a biology and a geology tour. There will also be a tour of the new U. S. Air Force Academy, temporarily located at Lowry Air Force Base, White House headquarters for President Eisenhower when he vacationed in Denver.

Friday's luncheon will be sponsored by the NSTA Committee on Business-Industry Relations. Details are not yet available, but previous convention affairs sponsored by this committee have always proved to be one of the meeting's highspots.

Friday evening will have its special sparkle. The exact details are still a secret. The program schedule now says simply: Entertainment—Springtime in the Rockies.

Saturday's pre-luncheon time will be devoted to "Here's How I Do It" meetings which will follow the earlier speaker-discussion session. The Saturday luncheon is being organized by the Colorado Science Teachers Association, a new but especially enthusiastic NSTA affiliate.

One of the special features at Denver will be two pre-convention conferences on the supervision of science instruction. Meeting Tuesday afternoon, March 25, one will be on the secondary school level, the other on the elementary school level. The latter is being planned primarily to give assistance to elementary supervisors whose responsibilities are general rather than for science alone. Both conferences will be open sessions with all interested welcome to attend.

More details—names of speakers, participating teachers, and other information—will be given in subsequent issues of *The Science Teacher.* In the meantime, start making your plans now for "Springtime in the Rockies."

At one of the early pre-convention planning meetings, the Denver committee met with Kenneth E. Oberholtzer, (seated, far right) Superintendent of the Denver Public Schools, to discuss how local teachers could help in the convention sessions. The committee members pictured are: seated, left to right, Chairman Donald G. Decker, Kathryn D. Ward, Davida E. Phillips, and Sam S. Blanc; standing, left to right, Robert H. Carleton, John Sternig, S. Winston Cram, Dean C. Stroud, Jeff West, and George Mathes. Mathes is chairman for local arrangements with Blanc as his co-chairman. One committee member was absent at this session, Marguerite R. Juchem.

NSTA Activities

Wanted: Nominee Names

With the 1957-58 NSTA officers barely started on their work for the year, it may seem a little too-far-ahead-of-the-times to start talking about nominees for posts for 1958-59. But the high caliber of NSTA's officers—both present and past—is due to the fact that a great deal of thought and consideration goes into the selection of the slate of nominees. Important, too, is the belief that NSTA's nominees for office should not represent the choice of a few, but, rather, the choice of the entire membership.

The nominating committee for next year's officers will not meet until later this year. But, in the meantime, they want suggestions from any and all members. Whom do you know who would be an efficient and interested officer or member of the board of directors—who will help further NSTA objectives and, even, give new direction to NSTA programs and projects?

For 1958-59, the following are to be elected: A president-elect (who will serve as president in 1959-60), a secretary, and a treasurer, and regional directors for regions II, IV, VI, and VIII. Write your suggestions directly to the chairman of this year's nominating committee: William F. Goins, Jr., 120-32 Farmer Boulevard, St. Albans 12, New York.

This is what you need to report in your letter: the full name, position, and address of the nominee you suggest; the NSTA position you recommend him or her for; and a brief biography giving the highlights of his or her professional interests, activities, and education.

In Print

October marks a special milestone in the history of NSTA publications. It is the debut month for the revamped *Elementary School Science Bulletin,* appearing in new dress—a specially-designed two-color offset publication—and in eight-page (instead of four) issues, eight (instead of six) times during the school year. October will also see the first appearance of the 1957-58 volume of *Tomorrow's Scientists,* also an eight-page two-color offset publication. It was so successful in this format last year that it has been increased from six to eight issues for this year.

ESSB, of course, is designed for the elementary science teacher—to stimulate ideas that will help develop science interests in the very young. *Tomorrow's Scientists* is the science publication for high school science students, featuring student by-line articles as well as articles from young career scientists and stories about new advances in science, engineering, and related fields.

Subscriptions to the two publications are on the same schedule: 50¢ per year for group subscriptions (five or more) to one address; $1 per year for individual subscriptions. Sustaining and Life members of NSTA, as well as Library subscribers, automatically receive one copy of each issue of the two publications.

Behind the Scenes

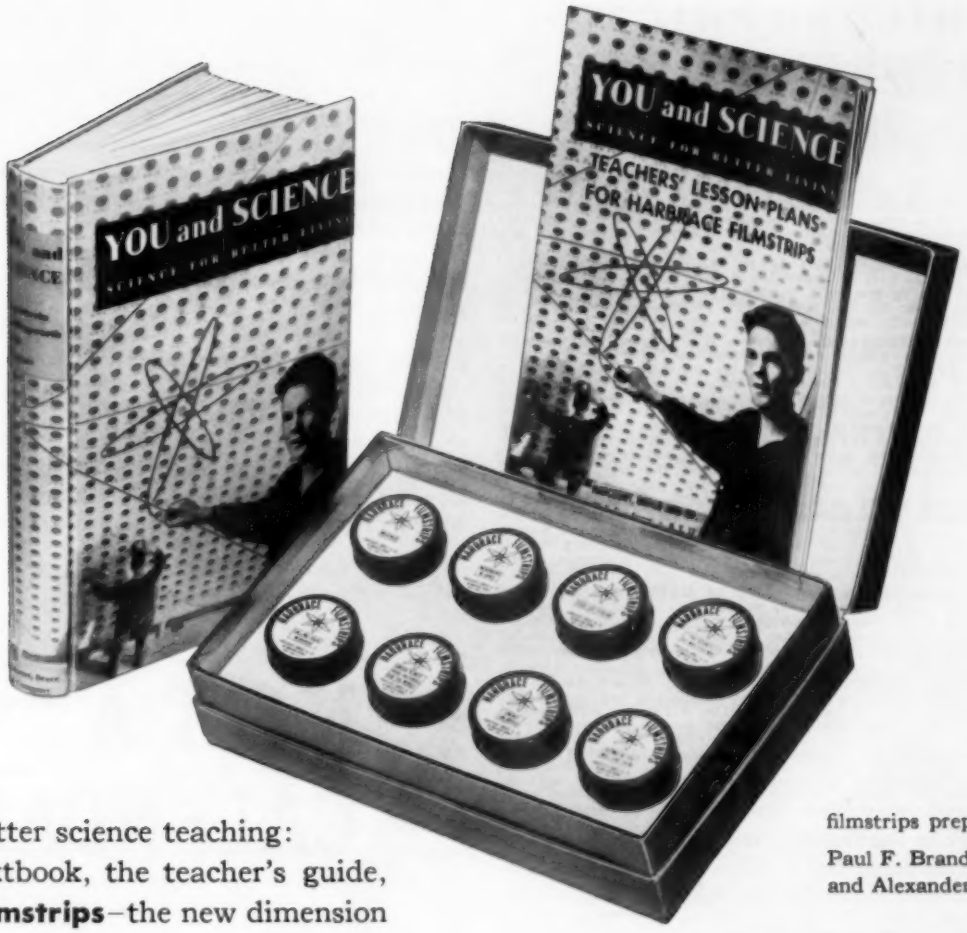
The story of the two publications sounds exciting and undoubtedly most NSTA members think of the finished product as the result of the work of NSTA staff members. They are—in part. But they are also the work of the too-often "unsung" heroes (and heroines) of the Association who, faithfully during their terms of service, dedicate much of their time and energy to committee work.

NSTA has some 25 committees now. The range of their activities is virtually enormous—planning everything from annual conventions to appraisals of science-teaching equipment. Future NSTA Activities columns will report on the work the various committees do. In this issue it seems fitting to give a brief summary of what the publications-related groups do.

There is, of course, the Magazine Advisory Board—which recommends on format, content ideas, advertising rates, and so forth, for *The Science Teacher.* They are literally an *advisory* group; the actual selection of articles is the responsibility of *TST's* editor just as the make-up of the magazine is his and that of his staff. But no drastic changes in style, content, or format would be made without the advice and counsel of the Advisory Board.

The Elementary School Science Committee and, particularly, its Sub-Committee, perform similar functions for *ESSB.* For example, the revamped *ESSB* could not have come into being had it not been for the enthusiastic thinking, planning, and pushing-through of the parent and sub-committees.

Tomorrow's Scientists operates on a slightly different basis. Its "advice and counsel" (as well as the hard work of gleaning, editing, and rewriting material) comes from specially-appointed contributing editors. This year they are Louis Alcorta, Chairman of Science and Mathematics, Galileo High School, San Francisco



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(California) Public Schools, and John Harlan, Science Department Chairman, Horace Mann Junior High School, San Francisco Public Schools.

In the same general field, there is also a publications committee whose job it is to recommend and work on special publications, such as the now famed "Bruce books" and this year's *Summer Employment of High School Science Teachers.* Another series, similar to the Bruce books, is now under consideration.

Finally, there is a yearbook committee which was appointed last year to develop proposals for a possible yearbook helpful to science teachers.

The work these and the other NSTA committees do goes on day-by-day. It's especially "unsung" because the members rarely have the advantage of meeting with each other. At the annual NSTA conventions—yes, with whomever is there attending. Otherwise, it's a by-mail job. But obviously the committee members love it, because they keep volunteering. And, incidentally, more volunteers are always welcome.

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST*'s calendar editor. Space limitations prevent listings of state and local meetings.

October 1957: National Science Youth Month

October 11-12, 1957: NSTA Northwest Regional Conference, State College of Washington, Pullman

October 18-19, 1957: NSTA Northeast Regional Conference, Hartford, Connecticut

November 6-8 1957: SAMA Laboratory Apparatus and Optical Sections Midyear Meeting, Chicago, Illinois

November 10-16, 1957: American Education Week

November 29-30, 1957: Annual Convention, Central Association of Science and Mathematics Teachers, Chicago, Illinois

December 27-30, 1957: NSTA Annual Winter Meeting with science teaching societies affiliated with the American Association for the Advancement of Science, Indianapolis, Indiana

March 26-29, 1958: NSTA Sixth National Convention, Denver, Colorado

April 24-25, 1958: 1958 Eastern States Health Education Conference, New York Academy of Medicine, New York City

June 25-26, 1958: NSTA Annual Summer Meeting with the National Education Association, The Ohio State University, Columbus

FSA Activities

Administrative Committee

The appointment of Zachariah Subarsky to the FSAF Administrative Committee completes the make-up of the ten-member group. Dr. Subarsky will serve a three-year term, for the period ending June 30, 1960. He fills the vacancy left by Henry H. Armsby who had served on the committee for five years. (For complete details about the current committee, see the item in FSA Activities in the September 1957 issue of *TST*, page 239.)

Head of the Annex at Bronx High School of Science, New York City, Dr. Subarsky has been an active member of NSTA and local and state teachers groups. He is a past secretary of NSTA.

Annual "Open Meeting"

The FSAF Administrative Committee will hold its annual "open meeting" this year on October 4. The city is Washington, D. C. and the group will hold an all-day session at the Hotel Statler. The purpose of the meeting is to report to the Foundation's business-industry sponsors and friends and to review and approve plans for the 1957-58 program.

Summer Conferences

It was a three-star calendar of summer conferences co-sponsored by FSAF this past summer in conjunction with industry groups. All three were reported as big successes with the Fellows commenting enthusiastically on the "dividends" they expect to reap in improvements in their science teaching.

The first two conferences met simultaneously but on opposite sides of the continent. One was the West Coast Summer Conference for High School Chemistry Teachers, the fourth annual West Coast session, which was held this year at San Jose State College in San Jose, California. The Crown Zellerbach Foundation was co-sponsor of the conference along with FSAF and San Jose State College. It was a two-week meeting from June 23 to July 6 with 36 Fellows in attendance.

Limited to high school chemistry teachers, the sessions emphasized demonstrations of lecture and laboratory experiments. The purpose was to develop demonstrations and follow-up procedures which will increase student understanding and develop a problem-solving approach to experimentation. The co-directors of the conference were Arthur L. Williams and Ronald R. Easter, both members of the Department of Chemistry at San Jose State College.

During this same period—June 23 to July 6—39 Fellows were meeting at the 1957 Summer Conference on the Improvement of Science Teaching held at the University of Maryland at College Park. The industry group co-sponsoring this meeting with FSAF and the University of Maryland was the West Virginia Pulp and Paper Company. The theme was "Effective Teaching and Career Counseling in the Junior and Senior High School Science Program."

The conference Fellows came from schools in Maryland, New York, Pennsylvania, South Carolina, and Virginia. Since they were teachers in areas where the West Virginia Pulp and Paper Company maintains plants, they were invited to visit the mills prior to the opening of the University of Maryland sessions.

The co-directors of the Maryland conference were Orval L. Ulry, Assistant Director of Summer Sessions at the University of Maryland, and Helen E. Hale, Supervisor of Senior High School Mathematics and Science, Baltimore County (Maryland) Public Schools.

The third session was a late summer meeting at Swarthmore College in Swarthmore, Pennsylvania. The dates were August 19 to 30. In addition to FSAF and Swarthmore College, the co-sponsors were the Scott Paper Company Foundation and the Division of Chemical Education of the American Chemical Society.

Twenty-five Fellows attended this conference, all teachers of chemistry from high schools in southeastern Pennsylvania. Designed to help improve high school chemistry teaching, the conference featured lectures on modern chemical concepts, principles, and applications; seminars on problems and practices in high school chemistry teaching; and field trips, laboratory visits, and interviews with scientists. The co-directors for this conference were Walter B. Keighton, Jr., Professor of Chemistry at Swarthmore College, and Robert H. Carleton, NSTA Executive Secretary.

There were several notable things about the 1957 summer program. For one, it marked the first time that three conferences were held under the FSAF banner. Last year there were two and previously, one. It also marked the first time that the West Virginia Pulp and Paper Company and the Scott Paper Company Foundation made grants for FSAF summer conferences. These facts indicate industry's growing belief that the improvement of science teaching is one of the most effective ways of helping produce more and better-trained scientists and engineers, so desperately needed in the nation.

KLOPFER . . . from page 265

many others received in the survey, it is plain that historical material generally "goes over well" with the students. This observation is important in our consideration of using historical material as subject matter for the development of scientific attitudes, appreciations, and interests. A most positive report of children's enthusiasm for historical material came from Mrs. Brenda Lansdown,* creator of the *Workbooks of Scientific Thinking* at The Dalton Schools in New York City. The three *Workbooks* definitely use the history of science in tracing the development of the chemical and physical knowledge of the atom from ancient times to the present, as is indicated in the titles:**

BOOK I *The Chemical Background of the Atom*
BOOK II *The Electrical Background of the Atom*
BOOK III *The Electronic Background of the Atom*

The highly successful use of the historically-based *Workbooks of Scientific Thinking* by one teacher and the success of other teachers with other forms of historical material, which we have already noted, both point toward potentially good results in the use of subject matter from the history of science.

In the past several months, a new series of experimental materials for science teachers has been prepared at the Harvard Graduate School of Education. The series is called *History of Science Cases for High Schools* and, to date, three preliminary cases have been completed. These take their cue from the *Harvard Case Histories on Experimental Science,* but they are, of course, designed for a younger audience, are shorter, and are more complete in themselves than their collegiate predecessors. The preliminary cases, as they are now prepared in mimeographed form, are intended to be directly useful to both students and teachers in secondary schools.

The *History of Science Cases* all embody several components. First, there is a narrative outline, which occupies most of the booklet. This narrative is accompanied by marginal notes and leading questions to point up the various aspects of science illustrated in the story. The marginal notes and questions should be the starting points for class discussion and investigations by individual students or groups. The essential component of a *History of Science Cases,* however, is the working out of actual experiments and problems by the students. Therefore, numerous suggestions for experiments and exercises are included in each case. There is also a short list of related readings for teachers and students.

As defined in the preliminary series, a *History of Science Cases* is a critical study of the development of a major scientific idea or concept. In the shorter cases, interest centers around only one or a few important discoveries. In every case, emphasis is placed on specific facets of science, such as the following:

1) The methods used by scientists.
2) The knowledge that science is made by men—not by machines or magicians. It follows that scientists are human beings and have human limitations; that they differ in temperament, outlook, emotions, ambition. We also note that scientists have certain *attitudes,* which we call scientific.
3) Science is an international activity; it is not confined to any nations, race, or group.
4) Science must have money to carry on.
5) Science must have free exchange of ideas—in meetings, journals, books, societies.
6) Constantly improved instruments and equipment are needed for progress in science.
7) Scientific activity is not isolated from, but is, to a large degree, the product of the culture in which it exists.
8) Science advances most rapidly when there is controversy.

Such ideas as these, when well understood by our students, may readily lead to the appreciation of and interest in science that we are trying to achieve in our science instruction.

For maximum effectiveness, it is not feasible, of course, to consider all the above facets of science at the same time. For this reason, in any one case, only some of these aspects of science are particularly emphasized, and these are spelled out in the marginal notes and questions. The following brief summaries of the three cases already prepared describe the highlights of the narratives and the aspects of science most strongly emphasized.

Preliminary Case A—THE SEXUALITY OF PLANTS

The notion that certain plants have separated "male and female" parts was known already in a practical way by the ancient Babylonians, but the knowledge did not become a scientific concept until several thousands years later. Nehemiah Grew was the first modern scientist to assert in 1676 that plants reproduce sexually and Rudolph Jacob Camerarius reported in 1694 the decisive

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* Now at Brooklyn College, Brooklyn, N. Y., Professor Lansdown also presented a vibrant report at the symposium on her experiences with the *Workbooks* in 11th grade science classes.

** BOOK I (printed) and BOOK II (mimeographed) are for sale by The Dalton School, 108 East 89 Street, New York 28, N. Y., at $1 each. BOOK III is still in manuscript.

observations and experiments. The concept was most firmly established when Carl Linnaeus incorporated it in his "Sexual System of Classification" in 1735 . . . The fascinating development in this case places greatest emphasis on experiment as an essential of scientific method, the byways followed in the growth of an important scientific concept, and the distinction between science and technology.

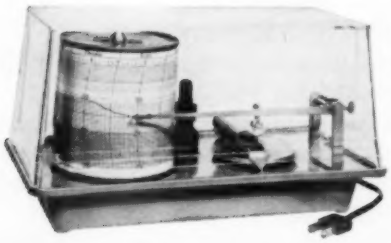
Preliminary Case B—
HOW FAR AWAY IS THE SUN?

A knowledge of the exact distance to the sun is rather vital to astronomers if they wish to estimate any of the dimensions of the universe, but this distance is not easy to measure. An important attempt to measure the distance to the sun, an attempt in which early Americans played a significant part, was made by observations on the transits of Venus in 1761 and 1769. These transits, especially the one in 1769, were eagerly watched by observers all over the world and in seven American colonies. Unfortunately, the observations did not produce a particularly reliable value for the sun's distance . . . Case B includes a rather neat problem in geometry and places chief emphasis on the importance of instruments, the international character of science, the "personal equation" of the scientist, and the means by which scientists communicate.

Preliminary Case C—
THE DISCOVERY OF BROMINE

The element bromine was discovered almost simultaneously by two chemists, Carl Löwig in Germany and Antoine-Jerome Balard in France. This discovery filled an important place in the reactive halogen series of elements and led to significant advances in 19th century chemistry. The story is especially interesting because the great discovery was narrowly missed by the distinguished chemist, Justus Liebig. . . . Case C calls attention to the need for scientific publications and the role of experimental technique in scientific method. The suggested experiments center on the properties of bromine and its compounds and on the relationships among the halogens.

The three preliminary cases just described are available to science teachers who may wish to use them in their teaching. Sample copies of one or all of the *History of Science Cases for High Schools* may be obtained free of charge from the authors of this paper by writing to The Graduate School of Education, Harvard University, Cambridge 38, Massachusetts.



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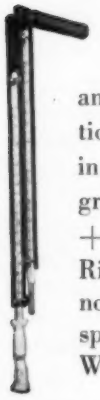

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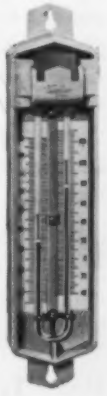

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ROBERTS . . . from page 269

sleeve. Using the bulb, raise the pressure in the sleeve to about 150 millimeters of mercury. Apply the bell of the stethoscope to the brachial artery just below the sleeve and lower the pressure very gradually until a sound is heard in the artery. Reading the manometer now gives the systolic pressure. At the time when the sound becomes muffled, read the manometer again for the diastolic pressure. Results are expressed as systolic pressure in mm. of mercury over diastolic pressure in mm. of mercury.

Pulse Rate

Run the second or third finger over the underside of the wrist until a continuing pulsation is felt. Using a watch with a second hand, count the pulsations for 30 seconds. Multiplying the resulting number by two gives the pulse rate per minute. Repeat this procedure until three consecutive determinations agree within one or two pulsations. Record the results. The average pulse rate for adults should be between 70 and 80 beats per minute.

Exercise to the point of a marked increase in breathing rate. Stepping up and down onto a chair 20 or 30 times should suffice. Repeat your pulse rate determinations immediately. Record results.

Check the pulse rate again at the end of three minutes and again after ten minutes.

Pulse Wave

The increase in pressure during contraction of the heart passes in a wave through the arteries; consequently, there is a lapse of time between the pulsation of an artery near the heart and that of one further from the heart. Locate your carotid pulse with the second and third fingers of the left hand and, at the same time, locate the pulse in the left wrist with the right hand.

Clotting Time

Draw several drops of blood into a capillary tube. At half-minute intervals break off a small portion of the tube until a thread of blood forms between the tube and the broken end. Normal clotting time is between five and 15 minutes.

Blood Typing

Blood can be typed both for A and B and for the Rh factors by fairly simple and conclusive laboratory procedures. Instructions for making these tests are always included in the package with the typing serum.

Bleeding Time

Clean the ear lobe with alcohol; make a puncture about 4 mm. in depth with a sterile needle. At the end of each half minute, blot the blood that has collected with a piece of filter paper. Continue blotting until no blood is obtained. Divide the number of drops by two to obtain the bleeding time in minutes. Normal bleeding time is between one and three minutes.

RESPIRATION

The fundamental concept in the study of animal respiration seems to be the continuing necessity of obtaining oxygen and disposing of the metabolic waste product, carbon dioxide. In animals with lungs this process is carried out by means of a set of tubes ending in air sacs which permit the two-way passage of gases. In the lungs oxygen passes out of the alveoli and carbon dioxide passes in as a result of a diffusion gradient. In the body cells where the carbon dioxide is present in greater concentration, the reverse process occurs. Both of these events can be conveniently demonstrated by use of a flannel board.

A. The overt aspect of respiration, i.e., breathing, consists of two phases:
   a. inspiration, which is brought about by an active contraction of the diaphragm and other respiratory muscles; and
   b. expiration, which is a passive process and which occurs as a result of the relaxation of the muscles which had previously contracted during inspiration.

   Artificial respiration (done by the new method) demonstrates the active and passive nature of respiration.

B. There are two factors which are generally considered to influence and control inspiration. These are nervous (reflexes) and chemical in nature.

   The nervous control of respiration is accomplished by a series of complex reflexes which are not easily demonstrated simply by observation. The effects of these reflexes are easily shown, however, when one recalls the changes which take place in respiration during excitement, fear, anger, pain, etc. Talking, sneezing, coughing, singing are forms of modified respiration.

Among the chemical factors affecting respiration, an excess of carbon dioxide seems to be of considerable importance. To demonstrate the effect

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of this gas the following procedures are recommended:

Determine how long you can hold your breath without severe discomfort. Then breathe deeply at the rate of about 15 breaths per minute. After this, see how long you can hold your breath.

Repeat the above experiment holding a paper bag over your mouth and nose and breathing into it for several minutes. Now see how long you are able to hold your breath. Compare the results of these procedures and attempt to explain any differences.

Sit quietly for three or four minutes. Exhale through a glass tube into 25 ml. of a .10 per cent solution of sodium carbonate containing two drops of the indicator phenolphthalein. The indicator is pink in alkaline solutions and colorless in acids. Determine how long it takes to decolorize the solution.

Now exercise by stepping up and down onto a chair 20 or 30 times. Repeat the experiment with a new sodium carbonate and phenolphthalein solution of the same quantity and concentration. When carbone dioxide passes into a water solution, one of the products is carbonic acid.

The act of swallowing is also a natural reflex and can be initiated by touching the back of the throat with a tongue depresser. Several mechanisms are brought into play during swallowing which act to keep solid particles and fluids out of the respiratory tract. This is necessary since the digestive and respiratory tracts naturally share a common opening.

The epiglottis is a cartilaginous flap of tissue which closes off the trachea during swallowing. In order for the epiglottis to perform this function, it is necessary for the tongue to be placed in the roof of the mouth with the tip against the upper front teeth during swallowing. By attempting to swallow with the tongue depressed against the lower front teeth, students learn that it is nearly impossible to do so. The inability to swallow with the tongue in such a position is a protective reflex, since the epiglottis would not close under these conditions. The usual passages at the back of the throat are also closed off during swallowing by the uvula, another cartilaginous flap of tissue which is suspended from the center of the back of the roof of the mouth. This structure lies up and backward over the nasal passages during swallowing.

Book Reviews

BIOLOGY. Elsbeth Kroeber, Walter H. Wolff, and Richard L. Weaver. 608p. $4.68. D. C. Heath and Company Boston. 1957.

When one sees a book with as attractive a cover as *Biology's*, it is well to examine the illustrations throughout the text to determine whether the book has simply been "dressed up." In this case the reader will probably be pleasantly surprised to find that nearly all of the great variety of both black and white and colored photographs and drawings, many of them in two colors, have been closely integrated with the text. Many of the illustrations may be used as a basis for questions and exercises.

Every school is surrounded with some and usually many available biological resources. Yet for one reason or another they frequently remain unnoticed or scarcely utilized. The introduction to *Biology* not only explains what biologists do and points out how to use the text, but suggests other ways to learn biology such as through field trips. Some interesting and specific suggestions are presented concerning where to go, what to take, and how to observe and collect specimens. Throughout the book there are many outdoor do-it-yourself activities suggested.

The organization of the book is excellent though not much different from some other modern biology textbooks. This book seems to be much more readable, however. Pronunciation of difficult words is given phonetically and new words are set in boldface. Essential technical terms are listed at the end of each chapter and a glossary at the end of the book should certainly aid pupils in mastering the vocabulary.

With an author having the wealth of experience in conservation education which Richard L. Weaver has, one is not surprised to find that the book contains a unit on conservation which is of exceptional quality as well as quantity. The problems of conservation are approached through an understanding of the basic ecology and the fundamental relationships of soils, water supplies, plants, and animals. Thus the students not only learn the reasons for the various conservation practices but begin to realize the part they themselves may play.

A Teacher's Manual, Workbook and Laboratory Manual, Comprehensive Tests, and Keys are also available as supplementary materials.

HOWARD B. OWENS
Supervisor of Secondary Education
Prince Georges County, Maryland

ECONOMIC PROBLEMS OF NATURAL RESOURCE USE. William H. Stead. 64p. $1.25. Joint Council on Economic Education, New York. 1957.

This publication emphasizes that effective implementation of solutions of our many resource problems can only come from a public which is competent to understand the seriousness and complexity of those problems and which accepts personal and civic responsibilities with regard to them. "To educators falls a responsibility to provide that understanding to the public, and they can do that only if they are informed."

Excellent background is provided for any teacher. The charts illustrating consumption rates of many resources, the study guide questions following each section of each chapter, and the bibliography add materially to the value of the publication.

F. OLIN CAPPS
Missouri Conservation Commission
Jefferson City, Missouri

PHYSICS—A MODERN APPROACH. L. Paul Elliott and William F. Wilcox. 658p. $5.12. The Macmillan Company, New York. 1957.

This textbook, intended for use in high school physics classes, is entirely new in authorship, content, and approach. The authors, the late L. Paul Elliott and William F. Wilcox, have had many years of experience in teaching physics, both at the high school and college levels. This very complete book contains all of the traditional subject matter and also such modern applications as rocket propulsion, color television, the transistor, and the manmade earth satellite.

But it is the authors' approach that makes this book unique. Each new topic or unit is introduced by a statement of a problem to which the student probably does not have a solution or answer. The problem is then examined from many angles so that the student can determine its solution for himself. An example of this approach is the problem of the corpuscular versus the wave theory of light. Evidence supporting both theories is presented and the student is led—as the scientists themselves were led—to the modern concept of the nature of light.

This approach relieves the teacher of the task of building background and explaining why certain theories have prevailed while others have been discarded. It also makes the text rather long so that, in all probability, the class and the teacher must decide which topics are of the most interest and value to them and which topics are to be studied by individuals and not as a class assignment.

To help the student determine his own understanding and mastery of the topic, each of the 53 chapters ends with a "Summary and Conclusions," "Questions for Review," a set of "Problems," a number of interesting "Projects," and a list of references of "Readings You Will Enjoy."

The physical appearance of the book is excellent. An attractive cover, many well drawn diagrams, a two-column page format, boldface type for paragraph headings, and the use of colored ink to emphasize laws, principles, and parts of diagrams combine to produce a favorable first impression and make the contents very readable and easily understood.

The student who is a slow reader might not be interested in the problem-solving approach of this book. The curious, alert, rapid learner and his teacher will find the history

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and philosophy of the development of the laws and principles of physics both interesting and enlightening.

MAHLON H. BUELL
Physics Teacher
Ann Arbor, Michigan, High School

WORKING WITH CHILDREN IN SCIENCE. Clark Hubler. 425p. $5.50. Houghton Mifflin Company, Boston. 1957.

Science is one of the most dynamic and fastest growing areas of learning in the elementary school curriculum. One reason is the professional leadership that has been given by a number of dedicated people who know children, science, and the elementary school. One of these leaders is Clark Hubler of Wheelock College and a Past President of the National Council for Elementary Science. Certainly, Dr. Hubler knows children, science, and the elementary school, and his book is replete with illustrations drawn from his experience.

The book consists of two sections. In the first section, general professional problems involved in developing science experiences are discussed with such chapter headings as "Science for Children," "Planning for Science," and "Science and Related Learnings." In this section, Dr. Hubler explores and discusses a number of the professional problems involved in developing science experiences. To illustrate his discussion, Dr. Hubler describes his experiences and the experiences of many other teachers in working with children. I particularly liked the chapter "Science and Related Learnings." Concrete experiences in the environment, such as science experiences, can help children develop meanings for printed words. The drive and desire to "find out about things" can provide the impetus for purposeful reading on the part of children. Science should be an integral part of the overall curriculum of the elementary school. Teachers have found science experiences of unquestioned value in the development of children's reading ability.

In the second section of the book, there are concrete suggestions as to how activities can be developed in such areas as "Interpreting the Sky," "Chemical Changes," "Experiences With Living Things," "A Variety of Experiences in Science," etc. This section is illustrated with exceptionally clear line drawings. Included are a number of science activities that, to my knowledge, have never before appeared in print. Of special interest are the many anecdotes and verbatim accounts of children's reactions, questions, and discussions concerning experiments, demonstrations, and events in the natural environment.

Working With Children in Science is designed for teachers and prospective teachers in the elementary and junior high schools. Although the elementary school and junior high school often are separated administratively, the educational experiences in both should be developmental, and in both schools science experiences should be general rather than specialized in nature. However, the stress in this book is on science in the elementary school; most of the examples are drawn from experiences with elementary school children.

This is an outstanding book worthy of a place in that special row of books on the desk of the person with professional interest in science for children. It should be handy for reference and ready for reflection.

WILLARD J. JACOBSON
Associate Professor of Natural Science
Teachers College, Columbia University
New York City

BOOK BRIEFS

OUT OF THE TEST TUBE: THE STORY OF CHEMISTRY. Harry N. Holmes. 313p. $4.50. Emerson Books, Inc., New York. 1957.

Fifth edition of widely-used reference; comprehensive revision with much new material; gives basic facts about chemistry, relating them to everyday living; historical data, developments in modern laboratories. Uncomplicated, readable style; effective drawings, diagrams.

ENERGY. Sir Oliver Lodge. 64p. $1.25. John F. Rider Publisher, Inc., New York. 1957.

Modernized, illustrated reprint of distinguished English physicist's 1929 work; absorbing account of principles of energy.

ROCKETS, MISSILES, AND MOONS. Charles Coombs. 256p. $3.75. William Morrow and Company, Inc., New York. 1957.

Just published "on top of the news" report on current missile, satellite, related programs; attention-holding, informative; 79 photographs.

ELECTRONICS FOR EVERYONE. Monroe Upton. 304p. 50¢. Signet Key Book, New American Library, New York. 1957.

Paperback reprint of revised, up-dated book; tells story of electricity from ancient to modern times; makes technical facts understandable; numerous drawings.

BOTANY: AN INTRODUCTION TO PLANT SCIENCE. Wilfred W. Robbins, T. Elliot Weier, C. Ralph Stocking. 578p. $6.95. John Wiley & Sons, Inc., New York. 1957.

Second edition of basic textbook; new material, modernized revisions; lucid definitions of scientific terms; suitable for science majors, terminal course for liberal arts students. Profusely illustrated.

CHEMISTRY CREATES A NEW WORLD. Bernard Jaffe. 321p. $4.50. Thomas Y. Crowell Company, New York. 1957.

Popularized account of chemistry, marvels it has generated; ranges from simple kitchen chemistry to nuclear power; stimulates interest in science careers. Easy style, nontechnical language.

THE MILKY WAY. Bart J. Bok and Priscilla F. Bok. 269p. $5.50. Harvard University Press, Cambridge, Mass. 1957.

Third edition of popular astronomy text; extensive revisions; vivid illustrations, graphs.

AUTOMATION: ITS PURPOSE AND FUTURE. Magnus Pyke. 191p. $10. Philosophical Library, New York. 1957.

Technical, highly literate review of results of perfection of the electronic computer in the 1940s; discusses possibilities of quick spread of automation in different countries, its potentiality for creating more leisure time and resultant social revolution.

MAMMALS OF THE GREAT LAKES REGION. William Henry Burt. 246p. $4.75. The University of Michigan Press, Ann Arbor, Mich.

Fact-filled summary of habits, life histories, economic importance, and distribution of mammals of Great Lakes region; 77 species keyed with maps; particularly interesting to outdoorsmen.

Audio-Visual REVIEWS

UNDERSTANDING OUR UNIVERSE. 10 min., 1957. B & W. Coronet Instructional Films, Coronet Bldg., Chicago 1, Ill.

Recommendation: Intermediate and junior high school levels.

Content: Tracing scientific history, the film first shows how the stars and sun were used to determine seasons and to guide the ancient shepherds by day and night. Then Copernicus established the sun as the center of the solar system and Galileo's subsequent invention of the telescope proved the earth is merely another planet. The film shows quite effectively the size of our galaxy and the tremendous scope of the universe. It explains how radio telescopes are now being used to detect radio signals from outer space. Speeded-up photography helps to show the great streams of hydrogen gas shooting out from the surface of the sun. The film makes it clear that scientific research is continuing in the pursuit of more knowledge about outer space.

Evaluation: Excellent instructional qualities. The facts reported are up to date and clearly presented.

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CARNIVOROUS PLANTS. 10 min. $90 Color. Moody Institute of Science, 11428 Santa Monica Blvd., Los Angeles 25, Calif.

Recommendation: Junior high school general science and senior high school and college biology areas.

Content: This study of carnivorous plants shows that many of them are more complex than any trap man has tried to design or even thought of. The structure and action of various species of these plants are presented in detail. The film demonstrates that many of the trapping mechanisms are actually only a specialized leaf.

Evaluation: Very good instructional qualities. The film should add many new technical words to student vocabularies.

◇ ◇ ◇

HOW WEATHER HELPS US. B & W, Color. Coronet Instructional Films, Coronet Bldg., Chicago 1, Ill.

Recommendation: Of general interest through senior high school levels.

Content: The film shows different kinds of weather, what snow is and how it helps plants during winter, types of clouds and some methods of recognizing and foretelling weather changes by clouds, and the importance of knowing weather conditions.

Evaluation: Effective in drawing attention to changes in weather and their effects on plants and animals. If the related questions are used, the film is valuable for use in a weather unit. Introductory work on cloud formations should precede showing of the film.

SOUNDS IN THE SEA. 16 min., 1955. $60 B & W, $120 Color. Moody Institute of Science, 11428 Santa Monica Blvd., Los Angeles 25, Calif.

Recommendation: Junior and senior high school levels in general science, physics, and biology areas.

Content: The facts that sound travels five times faster through water than through air, that the air-water boundary is an effective sound barrier, and that the human ear simply doesn't work well in water are all pointed out to the viewer. How the hydrophone was developed to detect sounds in the sea and how its use was expanded are very interestingly depicted.

Evaluation: An interest stimulating film which will help to build good scientific attitudes. It shows vividly that the old concept of the "silent deep" is no longer accepted.

◇ ◇ ◇

ANIMAL FRIENDS. $50 B & W, $100 Color. Film Associates, 10521 Santa Monica Blvd., Los Angeles 25, Calif.

Recommendation: Kindergarten and primary grades.

Content: Especially suitable for kindergarten, this is the story of Shep, a big patient dog, and Kitten, a very curious and playful kitten. The two have great fun playing and eating much to the delight of the viewers. Kitten daringly goes out to see the wide world but comes meowing back to Shep when frightened by strange things.

Evaluation: Delightfully amusing and effectively done. The film could be used successfully with an animal unit as it shows toad, tortoise, gopher, owl, and rabbit as well as dog and kitten.

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ATKIN . . . from page 272

ent is that few people are trained to do such work.

Probably the type of school system in which the consultant is most often employed today is the suburban school with the highest level of per capita expenditure. The science consultant will also be found in several small, private schools.

In most large cities, there are individuals who perform all of the functions of a science consultant as described, except for the fact that they have fewer face-to-face contacts with teachers and children. Most of their efforts are devoted to developing written curriculum materials and planning for long-range curriculum revision in the entire system. Occasionally, they will select individual schools in which to serve as a consultant, using more of the individualized relationships listed above.

Preparation of Consultants

Most people serving as science consultants today have a dual background of training: science and elementary education. Many of them are individuals who originally studied to teach science in the secondary school and later saw the need and importance for improved instruction in elementary science. Some of them are elementary school teachers who developed a strong interest in the science area. Many school systems insist that the consultant be an experienced classroom teacher since he will be helping such individuals to see science as part of a total elementary school classroom program.

While it is possible for an individual aspiring to be a science consultant to prepare himself by a careful selection of college courses, few institutions have established a curriculum specifically directed toward the preparation of such workers. Only a handful of people are thereby encouraged to pursue such studies.

If the elementary school science consultant idea has merit, there is a pronounced need for teacher education institutions to add courses and curricula to permit such specialization. At many colleges and universities, it is possible to prepare for positions as elementary school specialists in art, music, and physical education. Why not science?

Current programs of curriculum improvement in elementary science should certainly continue. Better pre-service programs are needed. In-service workshops *do* help. But in view of the pronounced need for improvement in this field, bolder steps must be taken to achieve the scope of change that is desirable. It seems to this writer that the soundest such step in the light of modern elementary school practice is the training and employment of more science consultants—people who know science *and* elementary education, people who can effect significant changes on a broad scale.

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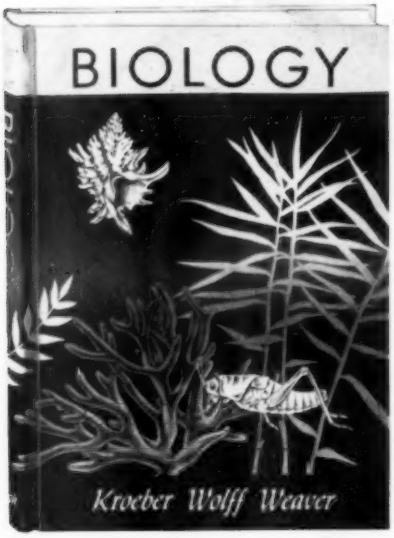

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